

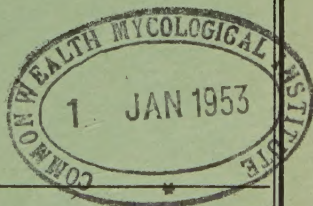
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Autumn 1952



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ARTICLES

NEW DEVELOPMENTS IN PIG FEEDING

JOHN DUCKWORTH

The Rowett Research Institute, Aberdeen

All feeding is a matter of bringing together materials that supplement one another, and of arranging things so that what is lacking in one is provided by another; the final mixture to be suited to the purpose intended. In pre-war days, the supplies of feedingstuffs were plentiful enough for nutritionists to be able to recommend various combinations of feedingstuffs so that the farmer could select the ration that was cheapest to make up according to the prevailing prices of the ingredients.

Rations in those days were extravagant. Ignorance of the exact needs of animals for many essential nutrients made it advisable to arrange to have plenty of each. More than that, certain feedingstuffs—particularly animal by-products—were known to be good carriers of vitamins and rich sources of “essential” amino-acids. Including them in rations was therefore a guard against shortages in the amounts of these nutrients in the rest of the ingredients of the ration, and also a possible protection against deficiencies of factors yet to be discovered.

This state of affairs involved only a nodding acquaintance with the science of nutrition. With ample supplies of feedingstuffs to draw upon, there was no incentive for farmers or scientists to set about discovering the kinds of rations most economical in *nutrients* as distinct from economical in *price*, and at the outbreak of war we had no co-ordinated body of information on what constituted the most economical rations that could be devised with our available feedingstuffs.

This matter is now being put right. Research in the general field of animal nutrition has been greatly increased and, among the workers concerned, many are devoting their efforts to solving this question of the minimum need of nutrients for growth and production so that, although we are still in the early stages of building up new feeding systems, it is already possible to report considerable achievements.

From the standpoint of more economical feeding of pigs and poultry, the recent discovery of vitamin B₁₂ as part of the “animal protein factor” is of outstanding importance. So, too, are the new evaluations of cereal and herbage proteins. A full understanding and application of these new findings seems to be essential if full national benefit is to be derived from the Ministry of Agriculture’s policy of increased cereal production.

Animal Protein and the Animal Protein Factor

It had long been suspected that the "insurance" value of animal by-products depended on something more than their content of high quality protein and of the vitamins so far discovered. Everything pointed to the existence of unidentified vitamins, and for simplicity it became customary to refer to them as the "animal protein factor." Eventually, one component of the factor was identified and isolated in pure form—vitamin B₁₂—and as knowledge of this new vitamin expanded it became clear that the term was a complete misnomer. Vitamin B₁₂ had very little to do with protein or with animals.

As far as is known with certainty, the vitamin is produced only by certain kinds of micro-organism, and its presence in animals and animal by-products is the result of the original animal having secured supplies of the vitamin during life, either directly or indirectly from microbial sources.

The direct source of vitamin B₁₂ is the microbial life of the rumen and the lower bowel. At each of these sites, a rich and varied flora of micro-organisms exists, producing among other things considerable amounts of this vitamin. It is believed that the animal absorbs some of the vitamin and stores up large reserves of it in the liver and kidney. Microbial synthesis, followed by absorption, is well established in the case of ruminants, but some uncertainty still remains in the case of non-ruminants.

The indirect source of the vitamin is the diet—and by "diet" is meant the *total* diet. This point is important. The diet contains vitamin B₁₂ not only from the animal by-products included in the ration but also as gained by the animal from access to soil and dung. Both these are sources of vitamin B₁₂ (dung fermenting in litter being a particularly rich source) and accordingly the mode of management determines the amount of vitamin B₁₂ which the animal finds for itself.

These three sources of vitamin B₁₂—intestinal synthesis, soil and fermenting dung—vary in their importance according to the age of the animal. The newly-born pig and the newly-hatched chick have no intestinal flora and, normally, little access to soil or fermenting dung. Accordingly, they depend upon the supply of vitamin B₁₂ in the ration and, partly, upon the reserves with which they are equipped at birth. As micro-organisms invade the intestinal tract and establish themselves there, the synthesis of vitamin B₁₂ gradually begins, and from then onwards the importance of the dietary source gradually diminishes. The need for a planned provision of vitamin B₁₂ in the ration is more rapidly reduced if the animals have access to soil and fermenting dung as they grow older. Once growth is well established in pigs or poultry there is no need for vitamin B₁₂ in the ration.

Although the intestinal production of vitamin B₁₂ is sufficient to meet the needs of the host during the later stages of growth and in adult life, it is not sufficient to meet the additional demands for the vitamin that arise in pregnancy. To meet the needs of the pregnant female and to ensure that her young are born with their own adequate

reserves, it is essential to have a dietary source of vitamin B₁₂ to supplement the intestinal source. How much extra is needed remains unknown, but as far as the sow is concerned there is no evidence to show that the inclusion of animal by-products in her ration at such levels as are usual during late pregnancy ever fails to supply all the vitamin B₁₂ she requires. The milk of the sow contains vitamin B₁₂ but, so far, the amount necessary in the feed to maintain a good supply in the milk is not known.

Vitamin B₁₂ is the only vitamin so far identified in the animal protein factor. Others may exist, but their distribution among feedstuffs may be very different from that of vitamin B₁₂. As matters stand at the moment, most of the attributes of what was originally known as the animal protein factor can be accounted for by its content of vitamin B₁₂. In other words, practically all the benefits that are derived from adding concentrates of the animal protein factor to experimental rations made up of vegetable feedstuffs would seem to be obtained by using instead a mixture of pure vitamins which includes vitamin B₁₂.

Animal by-products continue to be important as sources of "essential" amino-acids. The animal can synthesize all but about ten out of other amino-acids present in proteins. It is thus only necessary to supply proteins containing enough of a mixture of these for the animal to make such chemical rearrangements as are necessary to turn the dietary mixture into the mixture it needs for its varied physiological purposes. The "essential" amino-acids are those that it cannot synthesize out of other amino-acids in the ration or, at least, that it cannot synthesize at a sufficiently rapid rate to meet its daily need. These must be supplied in the ration, and the proteins of animal by-products are richer sources of them than are the proteins of vegetable feedstuffs.

During the rapid growth of early life, when proportionately more flesh is being formed, the demand for protein in the ration is greater than in subsequent stages of growth when the relative rate of increase of the body is lower and when the daily increment of tissue contains a lower proportion of muscle and a higher proportion of fat. Combined with this demand for a high level of protein is a need for a high proportion of essential amino-acids in the protein. The simplest method of solving the problem is to combine vegetable proteins with animal proteins so that the daily requirement for essential amino-acids is provided in the minimum quantity of total protein that will meet the animal's daily needs.

It is not strictly necessary to use animal protein. The relative poverty of vegetable proteins in essential amino-acids can be compensated for by increasing the level of vegetable protein in the ration. However, this method of increasing the concentration of essential amino-acids in the ration suffers from certain drawbacks in the case of at least one essential amino-acid, lysine: the daily requirement for lysine itself is increased by raising the protein content of the ration

NEW DEVELOPMENTS IN PIG FEEDING

so that even higher additions of vegetable protein must be made to satisfy the increased lysine need.

From both the standpoint of providing vitamin B₁₂ and that of providing a rich source of essential amino-acids to balance the lower quality vegetable proteins, the use of animal by-products in feeding pigs is most important during the last stages of pregnancy, during lactation and during the early life of the piglet. Economy in the use of animal by-products can be made with safety in later stages of growth and with the sow when reproductive demands upon her are slight.

Cereals in Pig Feeding

The foregoing observations are largely the outcome of fundamental research in nutrition. To put them to use in the farm feeding of pigs with home-grown cereals and limited supplies of bought-in protein concentrates involves the examination of the results of practical feeding experiments in the light cast by these new facts.

Outstanding among practical pig-feeding trials are those of Woodman and Evans[1, 2] of the School of Agriculture, Cambridge. Justice cannot be done here to all their contributions to our knowledge of the nutrition of the bacon pig, but Table 1 sets out some of the rations which they have found to be as satisfactory, for all practical purposes, as other rations more generously supplied with animal by-products.

Table 1
Weaner and Fattening Rations used by Woodman and Evans

TYPE OF RATION	WEANER RATION			FATTENING RATION
	Fishmeal (7 per cent)	Fishmeal (2 per cent)	No Fishmeal	No Fishmeal
<i>Composition of Ration</i>	<i>parts</i>	<i>parts</i>	<i>parts</i>	<i>parts</i>
Barley meal ..	60	58	54	75
Fine bran	29	29	26	23
Lucerne meal ..	3	3	3	2
Groundnut meal ..	—	6	15	—
Fishmeal	7	2	—	—
Minerals	1	2	2	2
Crude protein content (per cent)	13.9	13.9	16.8	12.4
Digestible crude pro- tein content (per cent)	11.3	11.2	13.9	9.1

All three weaner rations produced about the same rate of growth, the ration containing 7 per cent fishmeal being no better than the ration containing 2 per cent fishmeal, providing that the second ration had groundnut meal added to bring its content of total protein and digestible protein up to the level of the 7 per cent fishmeal ration.

When all the fishmeal was replaced by groundnut meal it was necessary to raise the content of total protein and digestible protein to higher levels in order to achieve the same growth rate. After 90 lb. live weight the fattening ration containing only 12.4 per cent total protein and 9.1 per cent digestible protein, almost all of which came from the cereal proteins of barley and bran, was sufficient to sustain a normal growth rate.

These results allow us to put a yardstick against recent discoveries about vitamin B₁₂, and, indeed, the entire animal protein factor, and about the essential amino-acids. It is clear that vitamin B₁₂, and whatever factors are grouped with it in the animal protein factor, need not be fed after weaning. Had the reserves built up in the piglet's body during the suckling period been inadequate, or had intestinal synthesis been inadequately established, then failure to maintain a good rate of growth would have been manifest in the pigs fed on the weaner ration containing no fishmeal. The fact that normal growth could be sustained by a ration in which all the protein was drawn from non-animal sources shows that the properly reared weanling is not dependent on a dietary source of the animal protein factor.

As the ration containing 7 per cent fishmeal and the ration containing 2 per cent fishmeal plus 6 per cent of groundnut meal both support normal growth with the same content of total and digestible protein, it is clear that the supplies of protein and essential amino-acids are adequate in each. The nutritive importance of the addition of only 2 per cent fishmeal is made clear when a comparison is made of this ration with the weaner ration containing no fishmeal. An extra 9 per cent groundnut meal, making 15 per cent in all, was necessary to provide the mixture of amino-acids needed for normal growth, with a consequent raising of the protein content of the ration from 13.9 per cent to 16.8 per cent. This is one of the most striking practical examples of the economy in the use of protein that follows the correct combining of animal and vegetable proteins to provide an efficient mixture of amino-acids.

Confirmation of the conclusions of Woodman and Evans has recently been obtained in Canada where McElroy and Draper[3] also found that cereal proteins have a high nutritive value for growth in the pig. Some of their results are shown in Table 2. These workers set out to determine the importance of protein supplements to cereals having different protein contents. In Western Canada the climatic conditions are such that cereals grown there may have remarkably high protein contents, wheat containing over 19 per cent protein being found in some cases. They used low, medium and high protein rates containing 9.5, 11.5 and 15.9 per cent protein respectively, and low, medium and high protein barley containing 9.1, 12.2 and 15.2 per cent protein. To one series, as shown in Table 2, they added no protein supplement, and to the second series they added different amounts of a protein supplement containing tankage 50, linseed oilmeal 25, fishmeal 7, lucerne meal 8, limestone 5 and iodized salt 5.

Table 2
Determining the Importance of Protein Supplements for Cereals of Different Protein Content for Feeding to Pigs
 Rations used by McElroy and Draper

TYPE OF RATION	CEREALS + MINERALS						CEREALS + PROTEIN SUPPLEMENT + MINERALS					
	Low Protein Cereals		Medium Protein Cereals		High Protein Cereals		Low Protein Cereals		Medium Protein Cereals		High Protein Cereals	
Protein Level in Ration	Wean- er*	Fatten- ing†	Wean- er*	Fatten- ing†	Wean- er*	Fatten- ing†	Wean- er*	Fatten- ing†	Wean- er*	Fatten- ing†	Wean- er*	Fatten- ing†
<i>Stage of Growth</i>												
RATION COMPOSITION‡												
Oats ..	39	9	39	9	39	9	33	9	36	9	37.75	9
Barley ..	59	89	59	89	59	89	51	81	54	86	56	87.5
Iodized salt ..	1	1	1	1	1	1	—	—	—	—	0.25	0.25
Ground limestone ..	1	1	1	1	1	1	—	—	—	—	—	0.25
Protein supplement ..	—	—	—	—	—	—	16	10	10	5	6	3
Average protein content	9.1	9.0	11.7	11.9	15.2	15.0	13.8	12.0	14.5	13.4	16.8	15.9
RESULTS												
Final weight lb.	196		201		204		208		204		205	
Feeding period days	208		183		151		137		141		132	
Gain per day lb.	0.81		0.94		1.16		1.30		1.24		1.32	
Feed per lb. L.W.												
increase lb.	4.61		4.06		3.72		3.69		3.86		3.50	
Carcass score per cent	37.3		57.6		65.0		71.0		65.7		70.7	

* Weaner ration fed from 30 lb. to 110 lb. live weight

† Fattening ration fed from 110 lb. to bacon weight

‡ All rations supplemented with cod liver oil

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Growth was slow in the groups of pigs fed on the low and medium protein cereals, but in the pigs fed on the high protein cereals growth was almost as good as when protein supplements were added. The pigs fed on the ration containing only high protein cereals (plus minerals and cod liver oil) required about two weeks longer to reach bacon weight than those given protein supplements. McElroy and Draper do not give full growth records in their report, but in the light of the results of Woodman and Evans it seems likely that the lack of animal protein in the early stages of growth after weaning would be responsible for the slight retardation of growth as a consequence of an inferior balance of amino-acids.

Considering these results together, it is clear that mixtures of oats, barley and bran require only a small supplement of protein concentrates, minerals and cod liver oil to convert them to balanced rations for pigs from weaning to bacon weight. The inclusion of small amounts of animal by-products sufficient to raise the protein content of weaner rations to about 14 per cent, together with a small addition of high quality lucerne meal, provides sufficient protein of the correct amino-acid constitution to satisfy the growth needs of the pig from weaning to 90 lb. live weight. Thereafter, the protein supplement can be left out, provided that the cereal grains are not too low in protein content.

Practical Considerations

In the hands of farmers, and of some experimenters too, poor results sometimes follow attempts at economy in the use of protein supplements. In some cases the reason for this is now obvious: the economy was tried too early in the pig's life, while its needs for important amino-acids were still high and before it could be independent of a supply of the animal protein factor in its ration. But a more important factor is often overlooked: the high variability in the protein content of cereals.

In this country, the average content of protein in wheat, oats and barley is 12.1, 10.3 and 10.0 per cent respectively. The range in protein content is not known for oats and wheat, but Russell and Bishop[4] found barley to range from 7 to 14 per cent protein ($N \times 6.25$) in their study of malting quality at Rothamsted. On soils of high water-holding capacity the variation from one year to another is small, but on light soils the annual variation is great. It is clear that the needs for protein supplements must vary widely from one farm to another, and from year to year.

Recommendations to farmers on what constitutes an adequate protein supplement for their home-grown cereals can be of two kinds. The first is to recommend supplements based on providing enough protein of the right kind so that even the cereals of lowest protein content will be adequately fortified. In such cases, there will be wastage of supplementary protein with all cereals of higher protein content. The second method is to analyse the farmer's grain stocks

NEW DEVELOPMENTS IN PIG FEEDING

for protein content and make the recommendation in the light of this value. In the case of the farmer with a large throughput of pigs the labour involved in sampling this grain and analysing the sample is not difficult to justify. About four-fifths of the feed needed to bring a pig from weaning to bacon weight is eaten after the pig reaches 90 lb. live weight, and this feed need not contain over 12.5 per cent of protein. Some grain samples need little or no supplementing while, at the other extreme, some need additions of 5 or 6 lb. protein per hundredweight of grain. Even small savings during the fattening period, when the amount of feed eaten is large, set free amounts of protein that are essential for supplementing rations during early life when the pig's demands are for small amounts of feed of high nutritive value.

Summary

Economy in the use of animal protein concentrates can be made during the fattening period. From the standpoints of vitamin and essential amino-acid supply, animal by-products are of greatest value in late pregnancy and lactation rations for the sow, and in creep feeds and weaner rations for the piglet.

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2. H. E. WOODMAN and R. E. EVANS. *J. agric. Sci.*, 1951, **41**, 102.
3. L. W. McELROY and H. H. DRAPER. *Scientif. Agric.*, 1949, **29**, 579.
4. E. J. RUSSELL and L. R. BISHOP. *J. Instit. Brewing*, 1933, **39**, Suppl. No. 7.

Precautions in the use of DNOC

When DNOC is used as a spray for weed control, it is known that precautions must be taken to eliminate the risk of poisoning to the operators. The use of this material is now becoming restricted to those crops which contain weeds which are less susceptible to the hormone weed killers, such as cleavers and mayweed. The effect of DNOC on animal life is perhaps less widely appreciated. Where, for example, game is preserved and valued, the use of DNOC should be confined to the cases mentioned above, and any risk of loss minimised by driving the birds out of the crop before it is sprayed, and attempting to keep them out for a day or so thereafter. So far as is possible, the sprayer should also be kept away from hedge banks at nesting time.

This note of warning is given as cases of serious loss have been known to occur. It is believed that MCPA and 2, 4-D are harmless to game.

THE MAINTENANCE OF SOIL STRUCTURE

A NOTE ON KRILIUM

J. B. E. PATTERSON

National Agricultural Advisory Service South-Western Province

The importance of maintaining a good structure in soils—especially for arable crops—or of improving poor structure where the relative proportions of sand and clay are not those most favourable for good structure, have been realized for many years. In the past twenty to thirty years the acceleration of the need for improving world food supplies and the losses of good soil by erosion or by deterioration in cropping power have forced soil physics to play an increasingly important part in agriculture.

Most agriculturists have a good conception of what they understand by “soil tilth,” but accurate definition of the factors which produce soils of good tilth and the mechanism of these factors is still elusive. Generally speaking, the chief criterion is the aggregation of the ultimate particles of soil into crumbs which are of a size to give the most suitable pore space for the percolation of water, the diffusion of carbon dioxide up from the subsoil, the retention of water for plant life, the free movements of air, and the easy penetration of roots, while remaining stable under repeated wetting and drying, and resisting crushing by farm implements, tractors and animals.

In the field, crumb formation is brought about by flocculation of clay particles, by living organisms, and by the cementing action of various polysaccharide gums and derivatives of lignin produced by the decomposition of organic matter by fungi and bacteria. The beneficial action of organic matter and the humus into which it is converted in promoting good stable crumb structure in soil is largely due to its being a source of these gums.

The mechanism of structure formation has been the subject of much research work during the past ten years, for the soil colloids do not of themselves produce the structure but only stabilize one already present. Mere quantity of organic matter is not important. Work in the U.S.A. has shown that recently ploughed prairie soils which have been used for arable cropping under poor systems of farming, may, in spite of a high content of organic matter, have a poorer structure than well-farmed soils of low organic matter content which have long been under arable cultivation. In this country, also, we need look no further than the Fens in the Eastern Counties for soils liable to windblowing, although the percentage of organic matter in them is very high.

Work by Swaby at Rothamsted and Sydney, and by others at Oxford, has shown that soil structure is improved and stabilized by certain portions of soil organic matter and not just by “organic matter” in itself. The process of decomposition of plant remains by

THE MAINTENANCE OF SOIL STRUCTURE

bacteria and fungi improves structure, and it has been found possible to separate polysaccharide and polyuronide gums secreted by certain types of bacteria and to obtain beneficial effects when they are mixed with soil.

Considerable strides have also been made in the development of synthetic polymers for soil conditioning, of which the sodium salt of a hydrolyzed polyacrylonitrile, or "krilium", is the principal example. It was evolved about three years ago in the U.S.A. and is now being tried in this country at research stations and by the N.A.A.S. in field trials. It is a light-yellow, water-soluble powder which acts rapidly in improving the structure of many types of soil when used at concentrations between 0.1 and 0.2 per cent of soil. The effect has been found to persist for about three years—which is as long as experimental evidence exists—and is dependent on the presence of small concentrations of exchangeable cations which assist in the adsorption of the one hundred or more polyanions to colloidal clay particles, binding the clay particles together by polymer bridges which can be seen as elastic threads when soil aggregates are drawn apart. In the stabilization process the water-holding capacity of the soil is often increased, with consequent easy workability at high water content.

An important use to which the material has been put in the U.S.A. is in the stabilization of soils liable to erode—such as road embankments—until grass or some other cover crop has had time to grow and hold the soil together by its root action. This anchoring of the surface skin of light soils on slopes is needed in this country in marginal land reclamation. Other experimental schemes of the N.A.A.S. include the rehabilitation of opencast coal sites, where the mechanical moving of the soil has destroyed structure and made the reseedling of the sites difficult; the effect on seedling emergence; the improvement of the structure of soils of high cropping value whose usefulness has been reduced by repeated growing of the same crop; and the measurement of the effect of the conditions on glasshouse soils as compared with the digging-in of peat or other organic materials.

The experience gained by the N.A.A.S. in the capabilities of synthetic soil conditioners will be of value in reinforcing the experimental work now being carried out at research institutes and by other bodies.

ABSTRACTS

ANIMAL BREEDING

A World Dictionary of Breeds, Types, and Varieties of Livestock.
I. L. MASON. Commonwealth Agricultural Bureaux.

Starting as a list of breed names and synonyms for the guidance of abstractors, this dictionary is now presented to the public with the rather astonishing total of about 3,600 entries drawn from all parts of the world. Where possible, details of geographical distribution, type of production, colour and horns are given as well as references to sources of further information. For those whose interest in livestock extends beyond their own parishes, this book will be most welcome, not only for reference but for the pleasure of browsing. To supplement the breed list, there are statistics showing the relative importance of the various breeds in many countries. Although the study of these statistics may leave the reader impressed by the large gaps in knowledge of the livestock resources of the world (including breed distribution in Great Britain), the author and the Commonwealth Bureau of Animal Breeding and Genetics have done well in making a start on the task of bringing order out of chaos.

H. P. D.

Inbred Versus Non-Inbred Boars used in Two Sire Herds on Wisconsin Farms. R. M. DURHAM, A. B. CHAPMAN and R. H. GRUMMER. *J. Anim. Sci.*, 1952, **11**, 134-55.

Co-operative pig-breeding schemes do not necessarily have to follow the familiar Danish pattern of litter-testing stations. The American experiment reported in this paper uses the results of four years' work when the authors collected records of over 4,000 pigs on forty-four farms in Wisconsin. On each farm one inbred boar and one boar of the farmer's choice were used, and comparison was made between top-cross progeny from the inbred boar and outbred progeny from the farmer's boar. Altogether, boars from some ten inbred lines of various breeds and breed crosses were used. The farmers' boars were also of several breeds—sometimes differing from that of the gilts in the herd, so that both types of boar gave crossbred progeny on some farms. A comparison of these crossbreds showed no significant differences, so that this factor was ignored in further comparisons.

On the average there was no difference in growth rate between top-cross and outbred pigs, but there was considerable variation in the performance of top-cross pigs sired by boars of the different inbred lines.

In litter size, survival, and weaning weights, the two groups showed no overall difference, and only small differences between lines. This

result was expected, since these characters are known to be chiefly determined by the sow and consequently would not depend upon the breeding of the boar. The boar will, however, influence the performance of his daughters, and the authors found the greatest difference between the two groups in the performance of the top-cross and outbred gilts when they were farrowed. The superiority of the top-cross gilts amounted, on the average, to 1.2 extra pigs farrowed, 1.1 extra pigs weaned, and the total weaning weight was 37 lb. heavier. Again, there was variation between lines—some giving better performing top-cross gilts than others—but all except one were superior to the outbred gilts. The lines which produced gilts of superior productivity also showed up well in respect of growth rate, so that selection of the best lines for commercial use in top-crossing promises to give a substantial all-round improvement in performance.

J. W. B. K.
H. P. D.

Heritability of the Udder Proportions in Dairy Cows. IVAR JOHANSSON and NILS KORKMAN. *Hereditas*, 1952, **38**, 131–51.

The udder proportions of dairy cows have a bearing on their milk production. For instance, if the fore-quarters give less milk than the rear-quarters they will, when milked by machine, suffer from periods of vacuum after milk ceases to flow. It is contended that this may injure the teat and cause mastitis; further, badly proportioned udders are often pendulous, a fault which lays them open to external injury.

The authors made observations on separate quarter milkings from about 600 cows of 22 herds representing three breeds of Swedish cattle. Their object was to discover the normal variation in udder proportions and how much of this variation was hereditary. They showed that the two front quarters gave on average only 41 per cent of the total udder yield, but that differences between the left and right halves of the udder were not significant. The proportion of milk given by the fore-quarters decreased slightly with the increasing age of the cow, indicating the possible development of subclinical mastitis. There were also indications that the front half of the udder dried off sooner than the rear half.

The authors made comparisons between dams and daughters and between half-sisters. They showed that about three-quarters of the difference in yield between fore- and rear-quarters is hereditary, but that differences between left and right sides of the udder are non-genetic. Unfortunately, a similar analysis with a dozen pairs of one-egg twins did not confirm these findings, but the reasons for this unexpected result may be, the authors think, due to mastitis infection of the twins' udders.

On the basis of these results, the prospects of selecting for improved symmetry of udders are good, but it must be borne in mind that the cows studied were from Swedish breeds of cattle. Differences in udder symmetry were considerable between the three breeds involved.

G. W.
H. P. D.

Effect of Advancing Lactation on the Butterfat Percentage of Milk. N. KORKMAN. *Z. Tierz. ZüchtBiol.* 1950, **59**, 98-111.

Change in fat content of milk during lactation has been studied by numerous investigators, but, hitherto, few attempts have been made to measure the extent to which this is due to heredity. By assigning numerical values to these changes the author is able to make such an estimate.

The material consists of data on at least eight lactations of 231 cows drawn from one Finnish and three Swedish breeds. As this data is highly selected, use is also made of third and fourth lactations of 554 Swedish Red and White cattle.

Previously, the effect of advancing lactation has been demonstrated chiefly by curves illustrating the trend of changes. After calving, fat percentage is high but sharply decreases as milk yield reaches a peak. It then shows a steady increase as milk yield decreases in the remaining months of lactation. The author obtains numerical values by calculating the regression of fat percentage on daily yield and on the time from calving. These measures are not completely satisfactory, but offer a useful means of comparing different lactations. The shape of the yield lactation curve in the Swedish herds is measured by expressing the pounds of butterfat in the second hundred-day period as a percentage of that produced in the first hundred-day period after calving. In the Finnish data, milk yield during the first five months of lactation is expressed as a percentage of the total.

Results show that fat percentage rises fastest (after the initial decline) during the lactations of heifers, but much more slowly in older cows. Variation in calving interval has no effect until the seventh month of lactation. Fat percentage then increases most rapidly during the shortest calving intervals in relation to the time since calving and decrease in daily yield. Early lactation changes in fat content account for most of the difference between mean fat percentages of successive lactations. The rise in fat percentage is greatest in cows producing milk richest in fat. This is true between breeds as well as between cows within a breed. Forty per cent of the variation in fat content during lactation is estimated to be due to inherited causes.

J. H. W.
H. P. D.

ANIMAL NUTRITION

Antibiotics

The employment of antibiotics as supplements in animal feeding has developed naturally from the utilization of fermentation residues as sources of A.P.F. ("Animal Protein Factor") and vitamin B₁₂. It was realized before long that the efficacy of these residues was not due only to the vitamin content, and so attention was directed to the small amount of antibiotic still remaining in them. Countless feeding trials

followed in which all classes of farm animals were plied with all kinds of antibiotics, and scores of papers have been published in U.S.A. journals.

Interest has been aroused in this country by these American reports, and the Agricultural Research Council has recently issued a statement outlining its attitude. It points out that pig foods in this country normally contain animal protein, whereas in the U.S.A. they are based mainly on maize and soya bean ; and in the presence of animal protein (containing A.P.F.) the antibiotic effect is less pronounced. Further, indiscriminate use of antibiotics may result in the production of resistant strains of pathogens, although it is conceded that this appears to be less likely in the case of aureomycin (the antibiotic most commonly employed), than in some others. The A.R.C. has stated that rigorously controlled experiments are in progress at various centres in Britain, and when the results have been examined statistically it will be possible to make appropriate recommendations.

American workers have used aureomycin, bacitracin, chloromycetin, penicillin, rimocidin, streptomycin and terramycin at various times. To save space, these are referred to later by their initial letters (e.g., A=aureomycin) : for the same reason, journal references have been omitted. Many reports have appeared in the *Journal of Animal Science*, the *Journal of Dairy Science*, the *Journal of Nutrition*, and *Poultry Science*, over the last year or two.

Ruminants

Owing to the dependance of ruminants upon bacterial fermentation, the possibility of antibiotics interfering with this function has always been to the fore, and the results are sometimes at variance.

Beef yearlings fed 2 mg. A per 1 lb. of dry matter for 150 days showed no significant difference from controls ; only a fleeting loss of appetite for the first few days was exhibited, together with some change in the ruminal flora. In another trial, 200 mg. A per day decreased the digestibility of dry matter and fibre in steers by 15 and 50 per cent respectively, which again suggested an interference with the flora. On the other hand, when 80 mg. A per day was given for the first time to ruminating dairy calves at four months of age, there was little or no adverse effect.

In that same experiment some calves received A from the first week (80-240 mg. daily), and at 200 days they were 30 per cent above the Ragsdale growth standards ; the controls were on the standards. Several other experiments (in some of which T was used as well as A) gave similar results. It was often remarked that there was less scouring in calves receiving antibiotics, and some workers attributed part of the beneficial effect to this. Although more food might be eaten, it was often more efficiently used ; thus an increase of 7 per cent in the consumption of digestible nutrients was accompanied in one case by a 16 per cent liveweight increase. It may be concluded that the young calf responds to antibiotics similarly to the non-ruminant, but that the

effect wears off with increasing maturity (calves supplemented with A were, at four months, gaining weight one-and-a-half times faster than the controls, but only at the same rate after another four months), and that the effect with animals upwards of a year may be adverse.

Two experiments with lambs may be mentioned. In one, the feeding of 100 mg. daily of either A, P or S, caused loss of appetite, scouring, and loss of weight; S was the least severe in its effect. In the other, 5 to 10 mg. daily of A caused a 20 per cent increase in liveweight gain and this was produced from 20 per cent less food. It would appear that the poor results of the first trial were due to gross overdosage.

Pigs

About thirty reports on pig experiments have been scanned for the present purpose, and these show agreement in placing A as the antibiotic *par excellence*. A was better than S in several cases but, in one, A+S surpassed A alone. Other trials in which several antibiotics were compared gave results such as : $S > P > P + S$; $A > T > B > P$; $A > T > C > B$; $A > T > P$. The relative inefficiency of P is noteworthy and is probably related to its instability in aqueous media; in one experiment, P was ineffective by mouth and by aqueous injection intramuscularly, but gave significant results when injected after suspension in oil.

The amounts of antibiotic employed usually lay between 5 and 20 mg. per lb. of dry food, and the effects were of the order of 10 to 50 per cent above the controls. The supplements produced their effect only as long as they continued to be administered; cessation of treatment caused cessation of effect. Also, litter size and viability and the growth of sucking pigs did not seem to be affected by treatment of the sow, but positive results were obtained by supplementing the creep feed. An interesting finding was that, whereas the pig at the weaner, store, and fatter stages required 16, 13 and 10 per cent of total protein respectively in the absence of A, 14, 11 and 8 per cent of protein sufficed when 10 mg. A per lb. was supplied: gains were greater and conversion more efficient.

Poultry

Antibiotics are also effective in stimulating the growth of poultry, but there would seem to be little difference in the efficiency of the various types. From several reports it appears that A, B, P, S and T all produce similar effects, a small advantage lying sometimes with one, sometimes with another. Additions to the laying bird did not affect hatchability or growth of the chicks. Interactions have sometimes been noticed when different antibiotics are present together; e.g., in one case $B + S$ gave better results than B, P or S singly, these in turn were better than $B + P + S$ which only equalled the control, and $B + P$ was slightly worse than the control (cf. above, $S > P > P + S$ in pigs).

Action of Antibiotics

The mode of action of antibiotics is usually attributed to their exerting a controlling effect over undesirable intestinal micro-organisms with consequent increase in desirable ones which manufacture growth factors. Evidence of this has been found both in Britain and America. Chicks in new housing have not grown better with antibiotics, whereas those in old houses have; the inference is that the old houses infected the chicks with deleterious organisms which were then overcome by the antibiotics, and that such infection was not possible from the new buildings so that the antibiotics had nothing to combat. A complication of the antibacterial theory is that rimocidin, effective against yeasts and moulds but not against bacteria, has produced a 50 per cent increase in growth rate of pigs by weaning time.

In conclusion, it may be mentioned that very recent work has been reported in which surface-active agents of a detergent nature have been found effective in promoting growth. An ethomid (produced from fatty acid) has been successfully used, and on a large scale of manufacture would be much cheaper than antibiotics. A new field for investigation is therefore opening and it is to be hoped that work on compounds of this type will be actively pursued.

S.M.B.

SOILS

Effect of Particle Size of Limestones on Soil Reaction, Exchangeable Cations, and Plant Growth. T. A. MEYER and G. W. VOLK. *Soil Sci.*, 1952, **73**, 37-52.

The fineness of ground limestones is important from several aspects—on their effect in correcting soil acidity and subsequent improvement in growth of crops, on the rate of application needed, on the cost of grinding (which increases markedly for very fine material) and on the ease of application by drill and spreading machine. It is generally recognized in this country that extreme fineness is not required to give quick availability; rather coarser material is cheaper to produce and much easier to handle. This study was undertaken to determine the relative effectiveness of various particle-sizes of the two types of limestone, namely calcitic and dolomitic. The work gives information on the influence of particle sizes, rate of application and time after application of limestones on reaction (pH) and exchangeable-cation changes in the soil, and the effect of these changes on growth and chemical composition of lucerne and soya beans.

Materials and Methods

Two acid silt loams were used, one with a lime requirement of 3-3½ tons $CaCO_3$ per acre, and the other 5-5½ tons per acre. Two limestones were tested—a calcitic limestone (91.6 per cent $CaCO_3$, 1 per cent $MgCO_3$) and a dolomitic limestone (53.3 per cent $CaCO_3$, 42.4 per

ABSTRACTS : SOILS

cent MgCO_3). By sieving, a series of fractions of different sizes were prepared, i.e., 4-8, 8-20, 20-30, 30-40, 40-50, 50-60, 60-80, 80-100 and over 100 mesh.

In one series of experiments each material was mixed with the soils in pots at varying rates up to 10 tons per acre ; these were kept moist without being cropped, and sampled at intervals for 18 months. In the other series lucerne was grown and cut five times over a period of 10 months ; subsequently soya beans were sown in the same soil and harvested when the beans were forming.

Chemical Effects in Uncropped Soils

pH. The change in pH varied with size of particles. With limestones coarser than 20 mesh there was very little change, but in the case of the finer particles there were gradual increases in pH with time ; for those of 60 mesh or finer the maximum pH was reached about 6 months after application, for 50-60-mesh material the highest pH was reached at about 12 months, while particles coarser than 50 mesh required at least 18 months to bring the soil to maximum pH values. There was little difference between the calcitic and dolomitic limestones. The former appeared to act a trifle quicker but after 9 months the dolomitic limestones maintained a slightly higher pH. At the end of 18 months, all particles finer than 40 mesh were approximately equal in correcting soil acidity. All material finer than 40 mesh was about ten times as effective as 8-20-mesh material and about twice as effective as 20-30-mesh material.

EXCHANGEABLE CALCIUM. The exchangeable calcium increased with all fractions over the 18 months period. Assuming the increase represents the amount of calcium dissolved, the results show that when 3 tons per acre of calcitic limestone was applied, 13 per cent of the 4-8-mesh material, 72 per cent of the 40-50-mesh, and 94 per cent of the material finer than 100 mesh, dissolved.

EXCHANGEABLE MAGNESIUM. The exchangeable magnesium in soils treated with calcitic limestone decreased with increasing rates and fineness, but when dolomitic limestone was applied there were increases with increasing rates and with fineness.

EXCHANGEABLE MANGANESE. Both calcitic and dolomitic limestones progressively reduced the exchangeable manganese when applied at increasing rates. There were marked reductions in manganese as the fineness increased, and in general the dolomitic limestone reduced the exchangeable manganese to a greater degree than did the calcitic limestone, regardless of rate or fineness of material.

Effect on Yield and Chemical Content of Crops

LUCERNE. The yields increased with increasing rate and with fineness up to about 50-mesh material. Calcitic limestones yielded significantly more lucerne than equivalent amounts of dolomitic limestones.

The percentage of calcium increased in the crop and that of magnesium decreased with increasing fineness when calcitic limestone was used. With dolomitic limestones of all states of fineness, both calcium and magnesium contents remained approximately constant. The total amounts of Ca and Mg in the crop increased with fineness for both calcitic and dolomitic limestones, but there was very little increase with materials finer than 30-40 mesh.

SOYA BEANS. Yields were higher on soils treated with dolomitic limestone than on those treated with calcitic limestone. The maximum yield with calcitic limestone was obtained with 60-80-mesh material, while with dolomitic limestone yields increased with increasing fineness of the material. The Ca content remained practically constant with dolomitic limestone but increased considerably with calcitic limestone as the fineness increased. Mg content remained constant with calcitic limestone up to 60-80-mesh material and decreased with material finer than 100 mesh; with dolomitic limestone Mg content increased to a maximum value with 60-80-mesh material and remained constant for the finer mesh fractions.

Chemical Effects in Cropped Soils

The pH was significantly higher on uncropped soils than on similarly-treated cropped soils. After cropping, the pH values were generally higher in the soils treated with calcitic limestone than in the soils treated with dolomitic limestone.

The exchangeable Ca in the soil after 14 months' cropping was higher when treated with calcitic limestone than when treated with dolomitic limestone. The percentage of Ca dissolved from added calcitic and dolomitic limestones was very low for the 4-8-mesh material, but 89 per cent dissolved when particles of 60-80 mesh were used. There was little difference in the effectiveness of limestone fractions finer than 60 mesh after 14 months' contact with the soil.

The exchangeable Mg increased rapidly with increasing fineness of the dolomitic limestone but with calcitic limestone it tended to decrease. Only 9 per cent of the Mg in the 4-8-mesh material dissolved, whereas 90 per cent in the material finer than 100 mesh dissolved in 14 months.

Exchangeable Mn was reduced with the application of the limestones—the finer the material the greater being the reduction. The Mn contents were much less in the cropped than in the uncropped soil.

Average Relative Efficiency of Limestone Fractions

The average relative efficiency of the various fractions was calculated from the average of the yields of lucerne and the changes in the soil, giving a value 0 to the no-lime treatment and 100 for the material passing a 100-mesh sieve when all fractions were applied at 3 tons per acre. The results show that the average relative efficiency of the calcitic materials was slightly higher than that of corresponding dolomitic materials. The 4-8 mesh calcitic and dolomitic limestones had negligible relative efficiencies of 5 and 8, while for the 20-30 mesh

fractions the values were 54 and 39. These, however, were not fine enough to cause significant soil changes and increases in plant growth within a reasonable time. The relative degrees of efficiency of the 40-50-mesh materials were 74 and 65, and those of the 60-80-mesh materials were 96 and 84.

Summary and Conclusions

Limestone particles coarser than 20 mesh were very slow in action and had little effect in correcting soil acidity; 20-60-mesh material induced little initial change in pH , but after 18 months approached the effectiveness of finer-sized particles; material finer than 100 mesh reacted soon after application.

After 18 months there was a consistent increase in the exchangeable Ca and Mg in the soil with increasing fineness for dolomitic limestone, while the Mg decreased after calcitic limestone was applied. The percentage of the applied Ca and Mg which dissolved in the soil depended mainly on the fineness of the materials. Exchangeable manganese decreased with increasing fineness of both limestones, and varied inversely with pH . Lucerne yields were higher in soils treated with calcitic than with dolomitic limestone, while the reverse was true with soya beans and yields increased with increasing degrees of fineness.

The writers' final conclusion is that 4-8-mesh material has little or no value as a liming material; that 20-30-mesh material may become effective over extended periods; and in order that agricultural limestones be effective within a year after application, a large proportion must be ground sufficiently fine to pass a 40-mesh sieve.

J. E. W.
W. M. D.

CROP HUSBANDRY

Fodder Beet

Castle, Foot and Rowland (*Emp. J. exp. Agric.*, 1952, **20**, 1-9) have published the results of comparative trials with fodder beet and mangolds during the three years 1947-49. The varieties of fodder beet used were Pajbjerg Rex IX and "Danish sugar beet Otofte for feeding purposes". The mangold used in 1948 and 1949 was Yellow Globe. The effect of 6 cwt. per acre sulphate of ammonia was studied at the same time. In their summary the writers point out that the average yield of cleaned beet varied from 22.4 tons per acre in 1948 (a wet year) to 13.1 tons in 1949 (a dry year): similarly, the yield of mangolds varied from 31.6 tons to 18.4 tons. The yields of dry matter per acre from the beet were 4.85 tons and 2.25 tons, and from the mangolds 3.87 tons and 1.7 tons respectively. The effect of a heavy nitrogenous top dressing was negligible in the dry season: in the wet year, the nitrogen significantly increased the yield of the mangolds but not of the fodder beet (roots).

Chocolate Spot of Beans

One of the worst enemies of the field bean is the fungus *Botrytis cinerea* which causes Chocolate Spot disease. S. H. Crowdy has described (*Ann. appl. Biol.*, 1951, **38**, 318-33) successful preliminary experiments using certain phenoxy alkyl carboxylic acids as systemic fungicides to control the fungus. These materials, which are related to the widely used plant growth regulators, can enter the plant through the leaves or the roots. The author is very cautious, but hopeful, in his conclusions. The subject is mentioned here only because of the great interest now being shown in bean-growing problems.

Ear Distortion in Cereals

E. C. Large and W. A. R. Dillon-Weston have described in detail, and have illustrated with photographs, types of ear distortion in wheat, barley and oats which sometimes follow the use of MCPA and 2,4-D as selective weed-killers. (*J. agric. Sci.*, 1951, **41**, 338-49.) In barley they distinguish between "bowed" or "trapped" ears in which the ears are not completely withdrawn from the sheath and a curved ear results; and "tweaked" ears in which there is an interruption of the normal regular alternate succession of spikelets, and the occurrence in its stead of opposite pairs or clusters of spikelets. They state that bowed ears resulted from applications of MCPA and 2,4-D up to the 2-leaf and early 3-leaf stages, and tweaked ears from applications at the 3-4-leaf stages. Applications after the 4-leaf stage caused no appreciable ear distortion in barley. No inheritance of the disorders was found in seed from affected crops. In spring oats, panicles became clustered and irregularly branched, and in addition the roots were distorted. The paper is especially valuable for the photographs, which show the exact stages of growth at which spraying was carried out.

Control of Weeds in Flax

Blackman, Holly and Cox (*J. agric. Sci.*, 1951, **41**, 322-37) have summarized thirty-seven field experiments conducted between 1942-50 to determine the conditions under which weeds in fibre flax can be selectively controlled by herbicides. Preliminary trials demonstrated that sulphuric acid, ammonium sulphamate, and ammonium thiocyanate were far too toxic to flax. Cupric sulphate, sodium DNOC and sodium MCPA were found to be the most promising. For all three compounds, flax is least liable to injury at a height range of 2-6 inches. There are limitations to the amounts which can be safely employed, namely, 20 lb. of cupric chloride or 6 lb. of sodium DNOC applied in 100 gallons of spray per acre. The limit of sodium MCPA is 1 lb. per acre, and the volume of application should not be reduced below 25 gallons per acre. The authors point out the complexity of the problem, which involves not only the selective destruction of weeds, but also the influence of the herbicide on seed production and the production of recoverable fibre.

G. E. F.
D. H. R.

MACHINERY

Green Crop Conservation Machinery

Costs of Green Crop Conservation

In "A study of the Economics of Green Crop Conservation, 1949 and 1950" (Farm Economics Branch, School of Agriculture, University of Cambridge, Rep. No. 38), data are analysed from a large number of Eastern Counties farms on which records were kept of the costs of haymaking, silage-making or grass-drying in the two years under review. Substantial numbers of farms were examined in each group of the survey: for example, forty grass driers were studied in 1949.

The results, both in 1949 and 1950, indicate that a mower and buckrake combination was the cheapest method of cutting and carting green crops for ensiling, and the use of pits was the cheapest method of conservation.

A conclusion drawn from the survey is that because of the high costs involved in grass-drying compared with haymaking and ensiling—often without compensating differences in quality—green crops should, where possible, be conserved by ensiling or haymaking. Ensiling appeared preferable to haymaking because of its greater independence of weather conditions. Cutting at early stages of growth was essential for high quality, whatever the process of conservation.

Sweeping and stacking was the cheapest method of hay harvesting in 1949, and sweeping to a stationary baler was the dearest. In 1950 cocking was cheaper per ton than sweeping and stacking; tripoding was cheaper than sweeping to a stationary baler. It was concluded that it is only possible to ensure good quality hay in inclement weather by tripoding or cocking. These two methods in 1950 were found to produce hay of superior quality.

Silage-Making in Sweden

In these same two years, 1949 and 1950, a study of silage-making in Sweden was carried out by the Swedish Institute of Agricultural Engineering and the Labour Study Department of the Swedish Federation of Agricultural Employers. The results of the study, which covered thirty-eight farms in southern and central Sweden, are recorded in Bulletin No. 238 of the Swedish Institute of Agricultural Engineering, Ultuna, Uppsala.

On all but one of these farms the silage was made in towers, and on most of them loading of the green material into the towers had been mechanized. Converted reaper-binders, in which a loading elevator had been substituted for the binding mechanism, were used on some farms to cut and load grass. Green-crop loaders and pick-up-chopper-loaders were also used.

Much grass for silage in Sweden is allowed to wilt between cutting and loading, and it is interesting to note that the loss in weight seemed to affect the amount of labour required to handle the crop, for in the methods examined systems using a cutter loader needed more labour

than those involving separate mowing and use of either a green-crop loader or a pick-up-chopper-loader. Spreading or turning of the swath before loading is seldom carried out, though it does speed up the wilting sometimes aimed at. Loading with a pick-up-chopper-loader or with a green-crop loader is usually done directly from the swath after the mower, but the fodder is sometimes put into small windrows.

Wilted, chopped fodder was found to give the heaviest loads and needed the least labour for transport. Changing the wagons is facilitated by suitable coupling devices between tractor and wagon, and between loader and wagon. Unchopped fodder was sometimes unloaded by a hoist, but dropping a whole load from the hoist down into the silo to be spread by hand is not to be recommended except as an emergency measure. Unchopped fodder can be taken up into the silo by means of a mechanical elevator or blower. Straw-blowers are most commonly used for this purpose, but special green-fodder blowers with a screw feed have been used experimentally.

Injector blowers such as are used in moving hay can also be used for moving green fodder, but they are not well adapted for the purpose as the power consumption is large and the blast makes it difficult to work in the silo. Moreover, they lack a useful feature of those straw-blowers in which the fodder passes through the fan house, for in such machines unchopped fodder is bruised so that it packs well into the silo.

In the silo, distribution of fodder and preservatives can be done mechanically. Two types of distributor were designed at the Swedish Institute of Agricultural Engineering some years ago, one being fully mechanical and the other manoeuvred by hand. The mechanical distributor has so far been used only to a small extent, but the hand-manoeuvred type is now common. The preservative AIV-acid is pumped to the distributor by centrifugal pumps made of acid-resistant metal. For molasses, gear pumps seem to be best. Devices for distributing ground oats and the like on to the fodder have also been designed and used.

Modified Design of Forage Harvester Cutterheads

In Wisconsin, U.S.A., experiments have been proceeding to modify the design of flywheel-type forage harvester cutterheads and so extend the range of sizes of cut for hay and green crops. The results of the work are given in a paper by Orrin I. Merge, "Design and Performance Characteristics of the Flywheel type Forage-harvester Cutterheads", *Agric. Engng.*, February 1951, **32**, No. 2.

Experiments at Wisconsin College of Agriculture had shown that long cuts of hay are more acceptable to cattle than short cuts, and therefore the redesigning of the cutterhead was directed to making it efficient in making long cuts. It was found that the modifications which made the machine capable of producing long hay cuts also made it more suitable for use in preparing maize for silage, since there is wider clearance for the material and a streamlined flow path.

Barn Drying of Hay

Research into barn drying of hay has continued in U.S.A. An important variable is the resistance of the hay to air flow, and many experiments have been undertaken to find what factors affect this resistance. Roy B. Davis Jr. and Vernon H. Baker, in a paper on the "Resistance of Long and Chopped Hay to Air Flow", *Agric. Engng*, February 1951, **32**, No. 2, bring together the results of several experiments on the subject, and relate them to the factors usually found in the practice of hay drying. Results seem to indicate that there is no appreciable difference between the resistance of long and chopped hay to air-flow. The method of loading and packing the hay in the mow has a considerable effect on the volume of air which can be blown through a unit of floor space, at a given static pressure. The amount of settling during drying varies with the initial moisture content of the hay. More settling takes place when the initial moisture content of the grass is high.

Chopping Silage

Publication No. 20 of Uitgave Van Het Instituut voor Landbouw-techniek en Rationalisatie, Wageningen, May 1952, reports fifty-one studies of silage-making by various methods, and compares the quality of silage made from unchopped grass treated with preservative layer by layer with the quality of silage made from grass chopped and mixed mechanically with the preservative. It was found that the feeding value of the mechanically-mixed silage was superior, and that the percentage of successful batches of silage was higher among those prepared from chopped and mixed material.

An interesting comment in this paper is a note that the capacity of forage harvesters equipped with a cutter bar is often limited by the width of cutter bar in the short crops being cut. This is in accord with the experience of the operators of some British grass-driers, who normally employ a "windrow and pick-up" technique to overcome the difficulty. The capacity required in a forage harvester for co-operative use in Holland is stated as 10 tons of grass per hour.

H. J. H.
C. C.

GLASSHOUSE CROPS

Ripening of Tomatoes. J. C. FIDLER and J. R. H. NASH-WORTHAM. *J. hort. Sci.*, April 1950, **25**, No. 3, and December 1950, **26**, No. 1.

When the variety Stonors' M.P. is grown in glasshouses the fruit may be ripened in reasonably short time by storage in air at 65-70°F. at high humidity, but the time taken for outdoor-grown tomatoes to ripen may be more than three weeks. So long as the fruit will ripen on the vines, it will presumably reach optimum quality if it is not picked

until it is ripe. Results of experiments involving the use of ethylene are puzzling, and it appears to be impossible to predict if an effect can be expected or not. The results list sixteen separate treatments of tomatoes with ethylene. Five gave acceleration of ripening of all the fruit (including those where the result was not clear-cut); in two, ripening of only part of the sample was accelerated, and in nine, ripening proceeded at the same rate in the presence or absence of ethylene. These included all the later experiments on fruit picked in October, and the use of ethylene appeared to be beneficial to less than half of the samples treated. Similar results were obtained with Canary Islands tomatoes, it being shown that the green and turning fruits can be ripened at 65°F. and that ethylene does not accelerate ripening.

The later experiments were designed to test the effect of continuous ethylene treatment as compared with application for two to five days only, as in the previous experiments. Fruits selected from the middle of the truss from glasshouse grown plants of Ailsa Craig and Potentate and showing the first traces of yellowing were put under experimental conditions the day they were picked. In the case of the outdoor varieties used (Hundredfold, Moneymaker and Donas), the state of maturity was more variable. Ethylene was used at the rate of 1 part to 650 parts of air, and in all experiments the relative humidity in the ripening chambers was high, but the speed of ripening was similar in air alone, or in air containing ethylene. These data confirm the previous conclusions that mature tomatoes may usually be ripened satisfactorily in a warm room with a fairly high relative humidity, and that the use of ethylene is not worth while.

The Storage and Ripening of Green Tomatoes. C. R. FURLONG.
Agriculture, 1946, **53**, 313-6.

In these experiments Harbinger was picked on September 3 and October 12 from outdoor plants, and Market King was picked on October 31 from plants grown under glass. The results indicated that for green fruit in general, it was possible to procure a supply of ripe fruit of good quality over a period of from 40 to 60 days by holding at 55°F. By holding at 65°F. this period was approximately halved. By using cool storage, i.e., by holding initially at 45°F. for not more than 14 days, the marketing period was prolonged by about a fortnight. The ripening of samples of the variety Market King was further retarded by storage for 28 days in a gas mixture containing 5 per cent oxygen + 10 per cent carbon dioxide + 85 per cent nitrogen at 50°F.—a maximum storage plus ripening period of 47 days being obtained.

E. S.

NUTRITION OF HORTICULTURAL CROPS

"Hard-Core," A Nutritional Disorder of Tomatoes. ELSA B. KIDSON. *J. Hort. Sci.*, 1950, 26, 8-21.

Outdoor tomatoes grown on a clay loam in the Nelson district of New Zealand are subject to "hard-core," and this disorder appears to be more prevalent in varieties producing a larger amount of fruit, e.g., Kondine and Potentate. Fruit of affected plants shows a greenish area around the stem end; in badly affected fruit the hard-core may extend through nearly all the solid tissue of the tomato. Even when the tomato is ripe the hard-core tissue remains tough, making such fruit unsuitable for canning.

At the experimental centre, the symptoms of hard-core were correlated with low potassium content of both leaves and fruit. It is pointed out, however, that other soils derived from different parent material did not produce the disorder in tomatoes, although similar potassium contents of the soil were found.

Soil sterilization with steam or chloropicrin tended to reduce the incidence of hard-core but failed to effect a complete cure. It is suggested that the interpretation of these results may indicate that root diseases—which are controlled by sterilizing—may limit the uptake of nutrients.

Rich organic manures such as cocoa husks and sheep manure were effective in reducing the amount of hard-core, being applied at a rate equal to 30 tons of dry matter per acre, and in addition to N.P.K. fertilizers. Heavy dressings of sulphate of potash reduced but did not eliminate the symptoms of hard-core. The addition of nitrogen to the potash fertilizer gave even better curative results.

These experiments suggest that the principal factors causing hard-core are the low content of potassium in the soil, coupled with the prevalence of root diseases. Other factors mentioned, possibly conducive to the disorder, are potash fixation and the unbalance of magnesium and calcium in the soil.

The Effects of some Acute Mineral Deficiencies on Glasshouse Chrysanthemums. J. H. L. MESSING and O. OWEN. *Rep. exp. Res. Sta., Cheshunt*, 1950, 57-60.

Chrysanthemums grown in sand culture were subjected to deficiencies of potash, boron and manganese.

The omission of boron caused the white varieties, in particular, to show malformation and a tendency to bruising of the florets. The incurved varieties were more susceptible than the reflexed, but the variety, Rose Harrison, was an exception.

The leaves grew to a reasonable size but were brittle and easily broke at the stem. The veins turned brown and cracked at different points; interveinal chlorosis occurred, followed by red and brown colours.

When manganese was omitted from the nutrient cultures, flowering was delayed, and size, colour and quality of bloom were reduced. Acute deficiency in the leaves was associated with interveinal yellowing in the leaves arising from the middle of the stem, and this was followed by a netting effect on the upper foliage in susceptible varieties.

When potash was deficient in the *early* stages of development, growth was reduced in all varieties. Marginal scorch of the leaves appeared, internodes were shortened and the older leaves died. The quality and colour of the blooms was not markedly affected, but size was reduced. A deficiency of potash in the later stage of growth did not cause any appreciable effects.

Sodium

The importance of sodium and its ability to replace potassium in horticultural crops has never been fully established. The beneficial use of common salt as a basic fertilizer for sugar beet in agriculture is, however, now a recognized practice. Whilst similar practices are known to horticulturists regarding their own crops, there is insufficient evidence to justify the economic use of salt or fertilizers containing sodium. On the other hand, an excess of sodium chloride in the soil can inhibit growth in certain crops and it is probably true to say that saline soils in certain parts of the world are more troublesome than those possibly lacking in sodium. In the following abstracts reference is made to some salient points relevant to this much-disputed plant nutrient.

Importance of Sodium for Plant Nutrition. V. Response of Crops other than Beet. J. J. LEHR. *Soil Sci.*, 1951, **72**, 157-66.

Long-term experiments based on pot and field trials, and using Chilean nitrate of soda and calcium nitrate at different potassium levels, are described. Trials were carried out on a humic sandy soil.

When calcium nitrate was used, symptoms of potash deficiency occurred in fodder beet, turnips and lupins. Sodium supplied in the form of nitrate of soda prevented such symptoms in turnips and lupins and considerably delayed their onset in fodder beet. Significant increases in yield were obtained after using sodium with low and high levels of potassium in the following crops: Westerwolth ryegrass, fodder beet, turnips, lupins and one of two potato varieties. The extra yield in turnips due to sodium in the presence of a high potassium level were offset by a lower dry-matter content. Generally, the response to sodium was least at a moderate potassium level and highest at the lowest potassium rate. The appearance and quality of the crops dressed with nitrate of soda were noticeably superior compared with those receiving calcium nitrate.

The author concludes that the physiological necessity for sodium in the presence of adequate potassium must be considered separately for each crop.

Salt Tolerance of Six Varieties of Lettuce. A. D. AYRES, C. H. WADLEIGH, LEON BERNSTEIN. *Proc. Amer. Soc. hort. Sci.*, 1951, **57**, 237-42.

Commercial lettuce production on irrigated soils in the south-west of America are subject to salinization due to the presence of salts in the irrigation waters. Experiments were designed to test the salt tolerance of several lettuce varieties. Normal irrigation water contained 300 p.p.m. of total salts.

The effect of adding increasing concentrations of salt to the soil reduced the size of heads without causing any leaf-burn, or any other noticeable symptoms. The plants, however, had a pronounced bluish-green colour compared with the controls. The highest concentration of salt caused the outer leaves to be thick and leathery. Increasing salinity caused a decrease in size and yield, and the six varieties were equally susceptible.

Chemical analyses of the leaf showed that chloride accumulation was most marked, and it is suggested that the concentration of this element might be the cause of growth inhibition. On the other hand, as toxicity symptoms due to chloride injury were absent it is concluded that the increase in the osmotic pressure of the soil solution limited the water supply to the plant.

The experiments established that the lettuce varieties grown commercially in irrigated valleys have moderate salt tolerance.

W. P.

VEGETABLE CROPS

Irrigation by Sprinkling. J. E. CHRISTIANSEN. *Univ. Calif. Agr. Exp. Sta.*, 1948, Bull. 670.

This comprehensive survey of sprinkler irrigation deals with almost every aspect of the subject including the design of spraylines, rotary rainers, portable and permanent piping layouts, and costs (in dollars) of equipment and operation.

The hydraulics of sprinkler systems are fully discussed, and there are numerous tables relating to frictional losses in pipes and hoses, nozzle throughputs, pump capacities, costing, and much information on the arrangement and performance of various types of rotary sprinklers.

The author compares sprinkler irrigation with surface and sub-surface irrigation—more usual practices in California. Even distribution of water is easier to achieve by sprinkling than by surface irrigation and, on undulating land, sprinkler apparatus may be cheaper than the levelling and ditching required for surface irrigation.

Generally, sprinkling is more economical of water than surface irrigation, but a considerable amount of water is lost by wind, and by evaporation from the spray, wet leaves and soil; when frequent light

applications have to be made, the water loss may be greater from sprinkling than from surface irrigation. Experiment shows that for a given penetration, the same quantity of water is required regardless of the method of application, but in very permeable soils, surface and sub-surface irrigation methods may waste much water by deep percolation beyond the reach of the plant roots.

Sprinkling for Irrigation. F. J. VEIHMAYER. *Univ. Calif. Agr. Exp. Sta.*, 1948, Circ. 388.

The bulletin is addressed to the Californian farmer who is considering the installation of a sprinkler system.

Fast- and slow-rotating heads, fixed heads, nozzle lines and perforated pipe systems are discussed. The author points out that permanent underground lines with their necessary risers are bound to interfere to some extent with cultivations, although once installed they are less costly to maintain and operate than portable systems.

A travelling sprinkler machine is described. This consists of a tractor geared down to travel at about 1-5 feet per minute alongside a ditch from which it draws water at the rate of 400-800 gallons per minute. The water is sprayed from nozzles mounted on the tractor to cover effectively a strip 250 feet wide. Such a machine costs less than an equivalent sprayline installation, and can be operated by one man.

The Effect of Wind on the Uniformity of Water Distribution by some Rotary Sprinklers. H. C. KORVEN. *Sci. Agric.*, 1952, **32**, 226-40.

Six common commercial types of rotary sprinklers were tested. The wealth of data presented includes mapped distribution patterns and computed "coefficients of uniformity". The data generally indicate that the performance of all the rainers leaves much to be desired. Uniformity decreased as wind speed increased. A low-trajectory rainer was no better than the other types in high winds.

Much work is needed to improve the design of rainers, and to determine the most satisfactory and economical spacing for commercial use.

Sub-Irrigation May Suit your Land. ALAN BLOOM. *Nurserym. & Seedsman.*, **113**, 604-5.

On reasonably level land overlying peat, silt or fine sand subsoil, the author claims that sub-irrigation is the best method. In Holland the water level in dykes and channels is manipulated to produce the required water tables beneath the crops.

The author has used sub-irrigation in a sandy peat soil at Bressingham with good results. The dry tilth was easier to preserve and annual weeds easier to control than with overhead irrigation. He suggests that a system of tile drains might be used to supply water to the land.

E. J. W.

DAIRY BACTERIOLOGY

Biochemical Methods for Bacteriology

In recent years, the popularity of micromethods has been increasing in bacteriology as in chemistry. In 1939, J. G. Davis in this laboratory showed that washed suspensions of bacterial cells gave more clear-cut results in sugar fermentations than growing cells in nutrient media containing the sugars. The use of cells in this way takes account only of preformed enzymes, and Patricia H. Clarke and S. T. Cowan (*J. Gen. Microbiol.*, 1952, **6**, 187) have applied the principle to a number of reactions, including fermentations, reduction of nitrates, methylene blue, indole, H_2S , acetoin, hydrolysis of starch, gelatin and urea.

Sterile technique is not necessary, but chemically-clean glassware must be used. Organisms are washed from a suitable solid medium with tap water, centrifuged to deposit the cells, and the deposit re-suspended in a small volume of water and used with the substrate. The method appears to have the advantages of simplicity, rapidity, reproducibility and economy, and the paper should be read in full.

Broken or Bitty Cream in Raw and Pasteurized Milk

This condition is well known, as it occurs widely in warm weather. The bacteriology of the fault is discussed by M. J. Stone and A. Rowlands (*J. Dairy Res.*, 1952, **19**, 51), who found that, of 161 cultures of aerobic spore-formers isolated from raw and pasteurized milk, 96 were *B. cereus*, 27 *B. mycoides*, 17 *B. subtilis*, 11 *B. sphaericus*, 3 *B. megatherium*, 2 *B. pumilis*, 1 *B. firmus*, and 4 unidentified strains. Broken cream, followed quickly by sweet curdling, was produced only by lecithinase-producing strains of *B. cereus* and some strains of *B. mycoides*. Spores of these organisms are found very commonly, in numbers sufficient to produce the fault, in raw and pasteurized milk, so that it is probably impossible completely to avoid broken cream. If, however, milk is cooled and kept as cool as possible before delivery and during household storage, the onset of the fault may be prevented long enough to permit the use of the milk.

The Effect of Penicillin on the Methylene Blue Reduction Time and Keeping Quality of Milk. A. ROWLANDS. *Proc. Soc. appl. Bact.*, 1951, **14**, 1.

The use of penicillin for the treatment of mastitis in cows in lactation has led to some difficulty in the manufacture of products, mainly because of the inhibition of the lactic streptococci.

The reduction of methylene blue at 37°C. and the direct clot-on-boiling test at 22°C. are used to determine the keeping quality of milk, and the author has studied the effect of adding penicillin at various concentrations to milk.

Using thirty-two samples from sixteen farms, penicillin was added in quantities of 0.25, 0.5 and 1.0 unit/ml. The reduction time of methylene blue at 37°C. was increased and the keeping quality improved

both in winter and summer. The addition of 0.25 unit/ml. was almost as effective as the higher quantities. In winter, increases in reduction time varied from 0-3 hours and, in summer, from 0-2½ hours. The increase in time to end point in the keeping-quality test ranged from 0-15 hours in winter and from 0-18 hours in summer. The response to penicillin differed in individual samples; the methylene blue reduction time was greatly increased in some cases although there was little effect on the keeping quality. In other samples the reverse effect was found.

In the control samples without penicillin, streptococci predominated in winter and in summer at the end point of the keeping-quality test, but when penicillin was present in the milk, gram negative rods often formed the majority flora. In winter, at the time of methylene blue reduction, the flora in the control samples consisted mainly of streptococci and micrococci, but with penicillin the proportion of gram negative rods increased. In summer, gram negative rods predominated in the control samples and in those with added penicillin.

The gram negative rods were unaffected by penicillin, but all the micrococci and most of the streptococci were sensitive. The resistant streptococci were strains of *Str. faecalis*.

It is likely that the variable distribution of resistant and sensitive organisms accounts for the variable effect of penicillin on the methylene blue reduction test, and on the keeping-quality test in different samples.

Seasonal Variation in Cheese Starter Activity. J. CZULAK and L. J. MEANWELL, *Proc. Soc. appl. Bact.*, **14**, 1.

Single strain starters were observed to be less active in H.T.S.T. pasteurized milk during the months October to April than they were in summer. If the milk was boiled the depression in activity was abolished. If small quantities of the inhibitory milk were added to autoclaved milk in which the cultures grew well, their activity was reduced. Cultures which were inhibited failed to grow in a good artificial (Nivens') medium, even when growth factors were added in increased quantities. From a culture failing to grow in milk, active cultures could be isolated and the "failing culture" revived.

The authors suggest an explanation for the observed facts by postulating a necessary growth factor, required in winter, which is rendered unavailable by a heat labile inhibitory substance. The inhibitory substance is believed to be present throughout the year, but in summer sufficient growth factor is present to overcome the inhibition. Uninhibited cultures are believed to be able to produce sufficient of the growth factor at all times to overcome inhibition.

Influence of Refrigerated Storage on Dye Reduction Time of Milk. C. K. JOHNS. *J. Milk Food Tech.*, 1952, **15**, 7.

In the 1939 edition of *Standard Methods for the Examination of Dairy Products*, storage of milk samples for periods up to 2 hours was permitted. It was found that this limitation was not being observed, and

in the 1948 edition the period was extended to 24 hours. The desirability of this latter concession was questioned by several workers.

Johns found that icing for even 2 hours slightly retarded the reduction of methylene blue. After 23 hours' icing, if the dye had already been added to the milk, the effect was rather greater, but not when the dye was added immediately before incubation began. With resazurin, however, the agreement was better when the dye was added at the time refrigeration began. The differences were not statistically significant in any of the experiments.

A. T. R. M.

DAIRY HUSBANDRY

Solids-not-Fat Content of Milk

A series of five survey studies investigating the variations that occur in the solids-not-fat percentage of milk have been reported by Bailey (*J. Dairy Res.*, 1952, **19**, 89, and 1952, **19**, 169.)

The first study dealt with the variations due to age and to correlations with milk fat and milk yield. It was found that the correlation between milk fat and solids-not-fat was statistically highly significant but that the value of the correlation was rather low. This is important, for it showed that with many cows there was no regular association of high levels of milk fat with high levels of solids-not-fat : it follows that a breeding policy planned to improve milk quality if based on milk fat tests only, without support from tests of solids-not-fat as well, cannot be expected to effect an improvement in the level of solids-not-fat in the milk of many of the cows.

The second survey was concerned with variations with stage in lactation. It was found that the level was high immediately after calving : it fell to a minimum level after 1-2 months of lactation, and then, if the animal was pregnant, climbed to the highest levels at the end of the lactation. If the animal was barren there was no recovery from the minimum levels. In the case of pregnant animals it was found that the rate of the climb was highest where the mean level of solids-not-fat was high, and also when the animal was old.

In the third survey the variations associated with the season of the year were considered. The level of solids-not-fat in the milk was found to rise significantly between the months of April and May, and again between August and September. From May to July the levels fell, and the extent of the fall was approximately equal to the sum of the rises in the other two periods. The coincidence of the rises with the periods of the rapid growth of grass was noted and its implications discussed.

Long-term trends were examined in the fourth survey. It was found that, for first-calvers of one breed in one herd, the mean level of solids-not-fat percentage fell approximately 0.25 per cent between the years

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1935-46. The extent of the fall depended on the months in which the tests were made. No decline occurred in May, but during the months of January, February, March, and April the fall was approximately 0.03 per cent per year.

Lastly, in the fifth survey, the effect of changes in feeding practice were examined. It was found that the solids-not-fat content of milk varied directly with the starch-equivalent content, and inversely with the dry matter content of the cow's rations. A significant increase in the amount of dry matter in the cow's rations occurred during the years 1935-46; this change was unaccompanied by any alteration in the starch-equivalent content of the rations, so it was believed that the long-term decline reported in the fourth survey was due primarily to this deterioration in the quality of the rations given to the cows.

Fat Content of Milk

The first of a series of papers on the fat content of milk from cows on diets low in hay and high in concentrates, by Balch, Balch, Bartlett, Cox and Rowlands (*J. Dairy Res.*, 1952, **19**, 39), provides conclusive evidence that diets low in roughage can greatly reduce the fat percentage of milk. Thus, a ration of 6 lb. hay, 30 lb. mangold, and concentrates to provide full requirements of starch-equivalent and protein-equivalent, gave a mean fat percentage about 0.5 per cent lower than on a diet which included 17-21 lb. hay daily, while the yield of milk was fully maintained. Where the hay was reduced to 2 lb. per head daily, a rather greater reduction in fat percentage took place and the milk yield was reduced. The low roughage diets also affected the iodine value and softening point of the butter fat produced, but had no effect on the level of solids-not-fat.

A. S. F.

POULTRY HUSBANDRY

Breeding

A great deal of interest has recently been taken by poultry-keepers in commercial laying flocks produced by the crossing of inbred lines. This subject is discussed by A. W. Greenwood and J. S. S. Blyth in "A Repeated Cross between Inbred Lines of Poultry," *J. agric. Sci.*, 1951, **41**, 367-70. The authors outline the questions now frequently posed by practical breeders: does a successful cross between inbred lines repeat itself with successive generations of the parental stock, and, bearing in mind the rapid degeneration experienced with most inbred lines, what is the optimal degree of inbreeding necessary to produce a sound commercial bird by the crossing of the inbred lines? The findings of the authors based on the inbred lines at their experimental station, demonstrated that in egg size and body weight the crosses were intermediate between the parental types, but were superior in winter egg production. This latter point will be of importance to

poultry-keepers, and also the finding that mortality in the offspring approximated to that of the parental line having the lower mortality rate.

The authors came to no definite conclusion regarding the deterioration in the offspring of successive generations of inbred lines, but the data suggest this probability.

Discussing another phase of the same problem, A. E. Bell, C. M. Moore, B. B. Bohren and D. C. Warren in "Systems of Breeding Designed to Utilize Heterosis in the Domestic Fowl" (*Poult. Sci.*, 1952, **31**, 11-22), deal with the practical utilization of "hybrid vigour" by the poultry-keeper in the field. The authors describe recurrent selection for "nicking" by two lines, and reciprocal selection, and compare these methods with more customary methods of selection in a closed flock. Bell and his co-workers consider the first two systems more effective. Recurrent selection for "nicking" is thought to be of greatest value in establishing a strain that gives rise to a maximum degree of heterosis when combined with an inbred line or single cross. Reciprocal selection, however, has a higher theoretical ceiling to possible improvement and has the advantage of employing proven strains. The authors add a word of warning by advising breeders not to throw over methods which have proved successful in their hands, until the newer systems described have proved themselves superior beyond all doubt in the hands of practising poultry-keepers.

With the stimulus now attaching to table-poultry improvement, an article by G. F. Godfrey and G. M. Farnsworth on the "Relation of the Sex-Linked Rapid Feathering Gene to Chick Growth and Mortality," (*ibid*, 65-8) is of topical interest. The authors describe how the progeny of several breeds were scored for rate of feathering on the basis of tail feather length at ten days' old. The mortality rates to ten weeks were subsequently related to the rate of feathering on the basis of sire families. It was found that the sex-linked rapid feathering gene (gene k) had no relation to body weight or mortality up to ten weeks. The action of the gene appears confined to the feather follicle and not concerned in any way with general body growth.

Nutrition

K. J. Carpenter and J. Duckworth in an account of "Economies in the Use of Animal By-Products in Poultry Rations, I" (*J. agric. Sci.*, 1951, **41**, 297-307), discuss the value of all-vegetable diets compared with diets to which animal protein has been added. The authors' conclusions are that birds fed on an all-vegetable diet, with groundnut meal forming the main source of protein, were as good in growth and food efficiency as those supplied with National Mash containing some animal protein. But performance up to six weeks old was inferior on the all-vegetable ration compared with that containing animal protein. This disadvantage could be corrected by the addition of condensed fish solubles and extra groundnut meal. The addition of aureomycin stimulated growth over the entire rearing period but failed to improve food conversion efficiency. The addition of aureomycin or animal protein factor(s) did not affect the age when laying began.

Miscellaneous

Recent accounts of high-laying birds attract one to a paper by J. R. G. Bradfield on "Radiographic Studies on the Formation of the Hen's Egg Shell" (*J. exp. Biol.*, 1951, 28, 125-40). The author describes the rate of formation of the hen's egg-shell and the movements undergone by the egg during formation. The description is supported by an interesting series of X-ray photographs—a method not apparently used for this purpose hitherto. Of special interest are the author's conclusions that shell deposition commences about five hours after the yolk is ovulated. During the first few hours in the shell gland the egg undergoes a substantial increase in volume. This increase is halted by the rapid advance in the rate of shell deposition, which later decreases. Throughout the twenty-hour stay in the shell gland the egg lies with its pointed end caudal, with the exception of the last hour or two. During this latter period the egg rotates 180 degrees in a horizontal plane and the egg thus emerges with the blunt end foremost. The rate of shell deposition and orientation of the egg in relation to the structure of the bird's oviduct and skeleton is discussed.

R. C.

ENTOMOLOGY

The Ecology of the Garden Chafer (*Phyllopertha horticola*) (L.) with Preliminary Observations on Control Measures. F. RAW. *Bull. ent. Res.*, November 1951, 42, Part 3.

This serious pest of poor quality permanent grassland occurs mostly on light, hilly land in areas where rainfall is relatively high. The adult beetles emerge in May or June, and are actively engaged in laying eggs during warm, sunny weather. This paper gives a very full account of the ecology of the pest, and particular attention has been directed to a study of the distribution and seasonal changes of populations of the larvae in infested fields. It was found that populations were reduced by ploughing and reseedling. Dusting with 3½ per cent benzene hexachloride dust gave promising results when applied at the rate of 70 lb. per acre in weather favourable to the beetles; this treatment kills the beetles and so reduces the number of eggs laid.

Common Vetch (*Vicia sativa*) as a Host of the Oat Strain of Stem Eelworm, *Ditylenchus dipsaci*. L. N. STANILAND and J. F. SOUTHEY. *J. Helminth*, 1951, 25, Nos. 1-2.

An interesting case of eelworm attack by the oat strain of the Stem eelworm occurred in a field near Lechlade, Gloucestershire. Very severe "tulip-root" of the oats resulted and the vetches in the field were also attacked, although rather less severely. Experiments on cross-transference of the eelworms from oats to vetches and *vice versa* are described; these experiments have proved that the same strain of eelworm attacks

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both crops. The effect of the eelworm on the vetches is to produce stunting of the plants and distortion of the leaves. The common fodder vetch must, therefore, be added to the list of plants susceptible to the oat strain of the Stem eelworm, and the sowing of vetches in fields known to be infested with this eelworm should be avoided.

Studies of the Clover Stem Nematode. K. T. FRANDSEN. *Acta agric. Scand.*, Stockholm, 1951, 1, No. 3.

This paper on Clover eelworm, which often causes heavy losses of the crop in Denmark, is of great importance and interest. Attacks fluctuate ; a correlation has been found between the amount of rain falling in May and June and severity of attacks. Under wet conditions, the clover grows vigorously and the eelworms spread easily.

Of particular interest is a description of the artificial infection of clover seedlings in the laboratory and in the field, which was carried out as part of an investigation into the varietal resistance of various strains of clover. Breeding for resistance, and selection work done so far on the basis of infection experiments, have already led to a significant increase of eelworm resistance in red clovers.

The Nature of Resistance to Stem Eelworm (*Ditylenchus dipsaci*) in Red Clover. S. BINGEFORS. *Acta agric. Scand.*, 1951, 1, 2.

The method of infesting clover seedlings with eelworm is again described in this paper ; and indeed, the author was the originator of the method. The behaviour of various strains of eelworm in red clover plants of the varieties known as Ultuna and Merkur has been studied, Ultuna being susceptible, whilst Merkur is resistant. It was shown that eelworms penetrate into both varieties, though rather less into Merkur, and further, that the eelworms are unable to propagate in resistant plants. It is also demonstrated that susceptible plants exist within the resistant strain of clover. Selection as well as breeding, therefore, offers a promising solution to the problem of Clover eelworm.

A Nematode attacking Strawberry Roots. A. N. BROOKS and J. R. CHRISTIE. *Proc. Florida State Hort. Soc.*, October-November 1950.

This new disease was first noticed in 1946-47, when plants were found to become semi-dormant ; no new growth was made and the edges of the leaflets became brown. The trouble was best described as a "decline". No eelworms could be found in the roots, but it was discovered later that the damage was due to an ectoparasitic eelworm (*Belonolaimus gracilis*) which is named the Sting Nematode. The effect of this external attack on the roots of the plants is described ; the root systems lack fine feeding roots and when new lateral roots were produced their tips were killed, in turn. The final result was the production of coarse roots with knobby tips.

Observations on the Attack by the Stem Eelworm (*Ditylenchus dipsaci*) on Strawberry. J. B. GOODEY. *Ann. app. Biol.*, September 1951, **38**, No. 3.

Four biologic races of Stem eelworm are shown to be capable of causing the disease on twelve varieties of strawberry. These eelworm races are of the oat-onion-rye, the red clover, narcissus and the teasle.

The symptoms of the disease are described ; these include crumpling and backward curling of the leaves, irregular leaf margins and increased brittleness of the leaves. Midribs and petioles are swollen as may be also the flower stems and runner stolons. Eelworms occur as well in the flowers and in fruits.

The Raspberry Cane Midge and its Control. R. S. PITCHER. *Ann. Rep. East Malling Res. Sta.*, 1950-51.

An account is given of damage caused by the larvae of this midge as a result of their feeding beneath the peeling bark of the canes. Such canes frequently suffer fungal invasion, particularly after the second generation of larvae.

Control should be aimed at the midge rather than at the fungus. An application of the benzene hexachloride wash, made by adding 2 lb. of a 50 per cent BHC wettable powder to 100 gallons of water, is recommended. Only the spawn need be sprayed, and a thorough wetting can be obtained with 300 gallons per acre. The first application should be during the first week in May, with a second spray 10-14 days later.

The Bionomics of *Lampronia rubiella*. the Raspberry Moth, in Scotland. A. R. HILL. *J. Hort. Sci.*, January, 1952, **27**, No. 1.

The most serious damage is caused by the larvae of this pest, which emerge from hibernation in the spring and bore into the developing buds on the canes ; secondary buds, when formed, may also be attacked. Pupation then takes place within attacked buds, the adult moths emerging to lay eggs in June and July. The young larvae feed in the flowers and developing fruitlets.

Biology of the Fruit Tree Red Spider Mite (*Metatetranychus ulmi*) in South-East England. CATHERINE A. BLAIR and JOAN R. GROVES. *J. Hort. Sci.*, January 1952, **27**, No. 1.

A very detailed account is given of this pest, and the principal factors influencing its population are shown to be : (1) the number of generations (five in Essex and Kent), (2) the effects of predator populations, (3) weather conditions, (4) effects of spraying (no really efficient spray has yet been found and some treatments cause increases in the mite populations), and (5) the dispersal of the mites from one orchard to another.

It has been found that unfertilized eggs always give rise to males, but the influence of this fact on the life cycle is shown to be insignificant.

The mouth parts of the mite are described, as well as the external and internal damage caused to the leaves.

Observations on the Dispersal of the Fruit Tree Red Spider Mite.

G. MARLE. *Ann. Rep. East Malling Res. Sta.*, 1950-51.

The dispersal of Red Spider has been studied in a wind tunnel. Wind was found to blow off only dead or damaged mites. When the wind stopped, however, female mites were observed to descend voluntarily on gossamer threads. It is still uncertain how the males migrate, but possibly they become entangled in the webbing of the females and drift with them.

Field investigations were also carried out by means of suction traps.

As a result of both types of investigation, it was found that parachute threads are normally formed in still air, following relatively calm periods, when the temperature is above 70° F. and relative humidity is low. A gentle breeze will then break the threads, and the mites will drift away. The number of migrants depends on the degree of infestation of the host.

Observations on Brown Rot (*Sclerotinia fructigena*) of Apples in Relation to Injury Caused by Earwigs (*Forficula auricularia*).

H. E. CROXALL, C. A. COLLINGWOOD and J. E. E. JENKINS. *Ann. appl. Biol.*, 1951, **38**, 833-42.

Observations have established a definite connection between the incidence of Brown Rot in apples and primary damage caused by earwigs. It was noticed that Brown Rot was often associated with shallow holes in the fruit, and these holes were found to be caused by earwigs. A survey, and also earwig-trapping experiments, have shown a close correlation between earwig damage and the amount of Brown Rot. Trapping was carried out by means of sacking bands, soaked in BHC, which were placed around the trunks.

The Tortrix *Cnephasia longana* on Fruit Trees in Essex.

H. C. GOUGH. *Plant Path.*, 1952, **1**, 31.

The caterpillars of this Tortrix moth tunnel into the tips of the shoots of apple trees, sometimes causing an open channel; they also feed in the folded leaves. Damage to leading shoots is important as it is likely to have a serious effect on the growth of the trees; similar damage has also been noted on pears and blackcurrants. It is reputed to have an extensive host range in various countries, including America. This moth has been recorded locally in England, south of Yorkshire, but this is the first instance when it has been observed as a pest.

Infection of Sugar Beets by *Ditylenchus destructor* Thorne, the Potato Rot Nematode.

C. E. DALLIMORE and G. THORNE. *Phytopathology*, 1951, **41**, 872-4.

The hosts of the potato rot nematode in the United States are potato tubers and dandelion. It was noticed that an infection of the eelworm in potatoes following three years of sugar beet was nearly twice as great as that following four consecutive years of potatoes. No infested roots

were found during examination of the beet from the fields, but the eelworm was successfully transferred from potatoes to beet under pot-culture conditions. The eelworms enter the beets near the crown and cause small discoloured areas to form, rapidly covering the whole crown. Dark, elongated welts may also spread downwards from the crown area. The injured tissues have a dry, honeycombed appearance; cracks occur later in the shrinking tissues. Eventually fungi and bacteria invade the tissues and the root may be entirely destroyed.

Observations on the Length of Dormancy in Certain Plant-Infecting Nematodes. M. J. FIELDING. *Proc. Helminth. Soc. Washington*, 18, No. 2, July 1951.

This paper records some interesting cases of the survival of eelworms in the dormant state in dried plant material. The infested plant material has been kept in a dried condition at room temperatures for a number of years and examined at intervals for survival of the eelworms. The results relate to several species of eelworm, but information obtained for the well-known Stem Eelworm (*Ditylenchus dipsaci*) are of general interest. This eelworm has been revived from dried Fuller's Teazel after twenty-three years; the percentage surviving was nearly 2 per cent, sufficient to start a fresh infestation. Among weed material which was examined, Cat's Ear (*Hypochaeris radicata*), stored dry for twenty years, contained eelworms which all revived. The remainder of any material containing live eelworms has been returned to store for further examinations in the future.

Particle Size of Insecticidal Suspensions and their Contact Toxicity. IV. Mechanisms of Action of Different-Sized Particles. A. H. McINTOSH. *Ann. appl. Biol.*, 1951, 38, 881-98.

While going into the matter in considerable detail, this paper brings out several points of interest to the practical user of insecticides. It is shown that large crystals of DDT kill just as efficiently as the very small particles present in colloidal DDT. This, however, did not prove to be the case when similar experiments were carried out with rotenone—colloidal particles being much more toxic than large crystals.

It is shown that when a contact poison is used, the chemical must first dissolve in the waxy layer on the outside of the cuticle of the insect, and it is suggested that the difference in the action of DDT and rotenone is probably due to their different solubilities in that wax. Small particles of rotenone would be more readily dissolved, whereas the solubility of DDT is very high in wax, and large particles will be as effective as small ones in attaining such solution.

Entry through body openings, such as the spiracles, appears to be unimportant in the case of DDT, since large crystals kill as quickly as small particles. Entry into the insect body by such means is of greater importance where rotenone is used, and small particles are then an advantage.

L. N. S.

MYCOLOGY

Cereal Diseases

Effects of Cultural Treatments on Wheat on the Incidence of Eyespot, Lodging, Take-All and Weeds. Field Experiments, 1945-48. MARY D. GLYNNE. *Ann. appl. Biol.*, 1951, **38**, 665-88.

During the seasons 1945-48, M. D. Glynne studied the effects of spraying wheat with sulphuric acid before emergence in the autumn and again in early spring; top-dressing with nitrogen in spring; and seeding rate on the fourth, fifth and sixth successive wheat crops, using the variety Squarehead's Master. The experiment was designed so that information on the interaction of these factors could also be obtained. In the fourth crop (1946), Eyespot (*Cercospora herpotrichoides*) and lodging were prevalent; in the fifth, weed infestation was severe; in the sixth, Eyespot, weeds, and Take-All (*Ophiobolus graminis*) were all troublesome. Spraying with sulphuric acid reduced the amount of Eyespot and lodging in 1946 and gave a good control of weeds in 1947, while in 1948 it reduced both lodging and weeds. On the plots which were top-dressed with sulphate of ammonia, acid spraying increased the yield in the three successive seasons by 2.7, 2.2, and 10 cwt. per acre. The effect on the yield of the other plots was negligible. Top-dressing with nitrogen in the spring caused an increase in the amount of Eyespot and lodging present at harvest time, and a reduction in the incidence of Take-All. There was consistently an increase in the weight of straw produced. If lodging was controlled by acid spraying or absent through seasonal conditions as in 1947, an increased yield of grain was obtained. The greatest increase in grain yield was obtained when Take-All was present in 1948. There were three seeding rates: 1, 2 and 3 bushels per acre in 1946, and $1\frac{1}{2}$, $2\frac{1}{2}$ and $3\frac{1}{2}$ bushels per acre in the following seasons. High seeding rates tended to increase the amount of Eyespot, and the most economic seeding rate was $1\frac{1}{2}$ -2 bushels per acre. Plots with this seeding rate and receiving 4 cwt. per acre sulphate of ammonia had yields for the three seasons of 28.4, 29.9 and 29.1 cwt. per acre. The yields of untreated plots sown with 3 - $3\frac{1}{2}$ bushels per acre fell from 26 cwt. in 1946 to 11.7 cwt. in 1948.

Sharp Eyespot as a Severe Disease of Oats. M. D. GLYNNE. *Nature*, 1950, **166**, 232.

The author reported that Sharp Eyespot caused by *Corticium solani* severely attacked an oat crop in Bedfordshire. Loss could not be estimated as eelworm was also present. In sand-culture experiments oats and rye were much more severely affected (50 per cent of the seedlings being killed) than wheat and barley by two cultures of the fungus isolated from Sharp Eyespot of wheat.

***Ophiobolus graminis* Sacc. var. *Avenae* E. M. Turner in Mid-Wales in 1948.** D. L. G. DAVIES. *Trans. Brit. mycol. Soc.*, 1950, **33**, 352-4.

Samples of stubble were collected from ninety fields in Brecon, Cardigan, Carmarthen, Pembroke, Radnor and Montgomery. In thirty-two samples, perithecia of *Ophiobolus graminis* were present, and in sixteen, hyphal plates only. From these perithecia the ascospores were always larger than those of the common form of *O. graminis*, and although the size range was greater than that recorded by Turner, and Garrett and Dennis, it supported the separation of var. *Avenae* as a distinct variety of *O. graminis*.

Varietal Resistance and Susceptibility of Oats to Powdery Mildew (*Erysiphe graminis*). E. J. JONES and D. J. GRIFFITHS. *Trans. Brit. mycol. Soc.*, 1952, **35**, 71-80.

Most varieties of oats tested were highly susceptible to Mildew attack ; a few showed a high degree of resistance but none were immune. *Avena strigosa* subsp. *hirstula*, *A. strigosa* var. *glabrota*, two diploid varieties, and a hexaploid variety, Cc. 4146, believed to be derived from a natural cross between *A. sativa* and *A. ludoviciana*, showed outstanding resistance both as seedlings and mature plants. On *A. strigosa* subsp. *hirstula* only a few necrotic spots were formed ; on *A. strigosa* var. *glabrota* there was a very slight mycelial growth but no spore production. A few opening pustules developed on Cc. 4146 in a cool greenhouse. A study of crosses indicated that resistance was dependent on a single factor pair. The authors conclude that it would be possible to combine resistance to both Mildew and Crown Rust with desirable agronomic characters. Considerable variation occurring in the reaction of some varieties during the course of the experiments (in which a composite inoculum was used) indicated the desirability of combining resistance studies with research on the possible existence of different physiologic races of the fungus.

Role of Fungi in the Heating of Moist Wheat. E. P. CARTER and G. Y. YOUNG. *U.S. Dept. Agric. Circular*, 1950, 838. (*Rev. appl. Mycol.*, 1952, **31**, 112.)

Of the many species of fungi isolated from soft and hard red winter wheat and hard red spring wheat, *Aspergillus* and *Penicilium* sp. were the most common on the surface of the grain, and *Alternaria* and *Aspergillus* sp. in the interior. The number of fungal spores per grain of No. 1 soft red winter wheat was estimated as 3,000 to 57,000, rising, after heating of moist grain, to several million. *A. candidus* was the fungus most often responsible for heating of grain, causing rises in temperature of 20-26°C. In moderately heated samples *A. glaucus* occurred most frequently. Treatment of moist wheat with new improved "Ceresan" or chloropicrin prevented heating, but such substances cannot

be used on grain intended for milling or animal consumption. Moist wheat stored in sealed vacuum containers did not heat, nor did steam-sterilized wheat. It is concluded that the heating of moist wheat in commercial storage is entirely due to the energy released by the respiration of fungi in or on the grain. The annual loss from this cause is calculated at two million dollars.

H. E. C.

PROVINCIAL NOTE

SOME SOIL PROBLEMS ON THE FEN PEATS

N. H. PIZER

N.A.A.S., Eastern Province

Roughly 350,000 acres of the Fenland is covered by peat deposits of various kinds, much of which is under intensive arable cultivation. The whole area is open and exposed to the influence of wind, and is one of the few areas in Britain where wind erosion or "blowing" can be a serious problem.

As the peats dry out in the surface, they become coarsely granular, or finely granular, or powdery, depending on the nature of the peat and the proportion of silt and clay mixed with it. When this occurs on a bare, cultivated surface, the slightest wind—and there appears to be always some wind in the Fens—disturbs and moves the powdery and finely granular peats. In strong winds, the peat may be lifted off the ground and blown away in thick, black clouds. This happens mostly in spring, when sugar beet or cereals have just been sown and have come through but are not yet covering the ground adequately; crop, soil and fertilizers may then be blown away into neighbouring fields or fill the dykes and ditches. This may occur more than once in the same season. To the cost of re-sowing the crop is thus added the often greater expense of cleaning out the ditches.

Blowing of the fens is very much a seasonal occurrence, being severe in some seasons and unimportant in others. It depends on the bareness of the soil, the firmness of the surface, the dryness of the peat, and the strength of the wind in the critical periods when the soil is not covered by a crop. Sometimes intense local heating of the black surface of the peat by the sun, and subsequent heating of the air above, appears to start a small cyclonic motion in the air ("dust devil") which whips up the peat and carries it away over a narrow track.

Claying to Prevent Erosion

The light and medium peats are difficult to make firm by rolling, and in an endeavour to make them bind together and reduce blowing, claying of the peats was carried out in the past and has been revived in recent years. The underlying fen clay or nearby upland clay is dug out and spread over the surface of the peat at the rate of 50-350 tons per acre. The fen clay is laminated and much less consolidated than the upland clay ; it appears to break apart and mix more readily with the peat, and for this reason is much preferred by many farmers.

Opinions differ as to the amount of clay that should be used—and indeed whether claying is of benefit. It may well be that the optimum rate varies from place to place, according to the properties of the clay and the nature of the peat. As far as the prevention of blowing is concerned, the heavier applications must affect compression by weight alone, and the binding properties of the clay presumably operate after incorporation with the peat.

There are other important effects of the addition of clay : some of these are beneficial, others are the reverse. Improved conditions for rooting and the absorption of plant nutrients may be brought about. The supply of some nutrients, such as potash, present in the clay, may be directly increased. The addition of calcareous clay to acid peat may reduce acidity, but heavy dressings may lead to manganese deficiency. On the other hand, manganese deficiency may be alleviated by incorporating an acid clay with alkaline peat. So much depends on the nature of the materials and the particular conditions under which they are used that generalizations are risky.

The physical effects of binding and consolidation result in firmer seedbeds, and appear to give better conditions for most crops, especially cereals and peas, which often finish badly and cannot be profitably grown until the peat has been clayed. This fact is most important agriculturally, especially where it is desirable to extend the rotation in order to avoid a build-up of sugar beet eelworm or potato root eelworm.

It has not been possible, as yet, to elucidate the effects of claying experimentally. There are many inherent difficulties, of which the chance of placing experimental plots in the path of a " blow " is one. Experiments are in progress and others may be put down in an endeavour to assess the effects of claying on the peat and on crop yields.

Mixing up peat with clay occurs in the normal course of land use when, as a result of shrinkage and wastage of the peat, the fen clay is sufficiently near to the surface to be brought up by ploughing. It is generally held that considerable improvement in the peat and in cropping results when this happens. One wonders, however, what the final outcome may be. The addition of clay no doubt slows up decomposition of the peat, but eventually the peat will disappear and an ill-drained, silty clay will be left. Shrinkage and wastage of the peat, to this extent, changes the local relief from the level surface of a deep peat to the irregular surface of the underlying clay with its banks, old drainage

SOME SOIL PROBLEMS ON THE FEN PEATS

channels and hollows. There will then be some complicated cultivation and drainage problems to deal with. Large parts of the peat areas that have been in arable cultivation for a long time are approaching this condition.

Acid Peats

In the Isle of Ely, between March and St. Ives, and extending northwards towards Crowland and beyond, are some areas of peculiar peats which are described as "drummy." These peats tend to be brownish in colour due to the presence of large amounts of ferric (iron) hydroxide. They are usually intensely acid, unless they have been limed, and they dry out to a dusty condition which is very difficult to wet. They dry out much more rapidly than other peats, and cereal crops, in particular, suffer from drought and acidity. In examples which have been examined, iron hydroxide appears to have been deposited in and around the peat at some stage in its formation, possibly from ground water containing ferrous salts such as ferrous sulphate in solution. The iron hydroxide appears to be intimately bound to the peat and on drying-out prevents re-wetting and absorption of water to the extent previously possible. Very heavy liming is needed to deal with the acidity of these peats; quantities of 20 to 30 tons per acre of ground carbonate of lime are needed as an initial dressing. Liming does not always make them productive but extends the range of cropping. Claying might put body into them and improve their capacity to hold moisture, but the best treatment for them has not yet been found.

Manurial Problems

In conclusion, the fen peats present many manurial problems which are not yet solved. They appear to be generally responsive to water-soluble phosphate, and to require less nitrogen than mineral soils. Large areas which overlie sand or gravel are deficient in potash. Manganese deficiency is also fairly common, whilst, recently, some serious cases of copper deficiency have been found. Although field experiments have been carried out to ascertain the most suitable manuring for individual crops, the fact remains that the peats themselves and the conditions under which they occur are so variable and changing that many more experiments are needed to ascertain local requirements.

FERTILIZERS : SUGGESTED HIGHER LEVEL OF CONSUMPTION

FERTILIZERS : SUGGESTED HIGHER LEVEL OF CONSUMPTION

Earlier in the year, the Fertilizer Sub-Committee of the Food and Agriculture Committee of the Organisation for European Economic Co-operation made a study of the difference in the consumption of fertilizers in the various participating countries, and asked to be supplied with information on the maximum amount of fertilizers which could be used to advantage in each country and, at the same time, might be expected to yield a profit. It is appreciated that any estimate of this nature must be largely theoretical and would vary with changes in crop and fertilizer prices. Nevertheless, in an attempt to meet the request for information in the time available, the following note on United Kingdom fertilizer consumption was sent to the O.E.E.C. Committee.

Present Level of Consumption

Fertilizer consumption in recent years in the United Kingdom has been as follows :

		<i>long tons</i>				
		1946-47	1947-48	1948-49	1949-50	1950-51
N	...	163,600	185,000	184,600	225,100	215,400
P ₂ O ₅	...	356,900	396,400	418,800	460,600	423,300
K ₂ O	...	120,600	179,800	196,000	234,000	226,400

In the present year, 1951-52, it is already clear that there will be a substantial reduction in purchases by farmers, largely because of steeply rising prices caused by the final withdrawal of the wartime subsidy and higher cost of materials and freights. Many farmers laid in stocks of fertilizers against the rise in price on July 1, 1951, and the figures shown above for consumption in 1949-50 and 1950-51 are rather inflated by this overbuying. These stocks will be used in 1951-52 and will offset, to some extent, the reduced buying in that year.

Maximum Profitable Level of Consumption

No attempt has been made to estimate the optimum usage of fertilizers, but rather it has been the aim to suggest the maximum amount that could be used and, at the same time, would give the farmer a profit from the increased yield. The rates of dressings shown in the following table are, of course, average dressings. Because of varying soil conditions, substantially higher rates could be profitably used in some parts of the country, while in other parts the profitable rates would be lower. The rates are based on field trials and tests over a long period of years, and on the experience of members of the Advisory Services. The rates would vary with any substantial changes in the prices of fertilizers or of agricultural products. It must be emphasized that the rates proposed for grassland are based on the assumption that the grass will be properly managed, and that it would be possible to use profitably the whole of

FERTILIZERS : SUGGESTED HIGHER LEVEL OF CONSUMPTION

the additional grass produced. Fundamentally, this would require better methods of conservation and a greater production in the off-season.

	<i>Acres (thou- sands)</i>	RATES PER ACRE			MAXIMUM PROFITABLE CONSUMPTION		
		N <i>cwt.</i>	P ₂ O ₅ <i>cwt.</i>	K ₂ O <i>cwt.</i>	N <i>tons</i>	P ₂ O ₅ <i>tons</i>	K ₂ O <i>tons</i>
Cereals ...	7,786	0.3*	0.1†	0.15	116,790	38,930	58,395
Potatoes ...	1,050	1.1	0.8	1.5	57,750	42,000	78,750
Sugar beet ...	425	1.0	0.8	0.8	21,250	17,000	17,000
Fodder crops ...	1,426	0.8	0.9	0.6	57,040	64,170	42,780
Vegetables ...	417	0.8	0.9	1.0	16,680	18,765	20,850
Temporary grass	5,796	0.4	0.4	0.2	115,920	115,920	57,960
Permanent grass	13,134	0.1	0.4	0.1	65,670	262,680	65,670
Totals ...					451,100	559,465	341,405

* On basis of one-third receiving 0.6 cwt. N per acre, one-third 0.3 cwt. N, and the remainder nil.

† On basis of one-third receiving 0.3 cwt. P₂O₅ per acre and the remainder nil.

Ways and Means of Attaining Maximum Level

It is regarded as unrealistic to expect that the level of consumption shown in the above table can be attained in the foreseeable future by normal democratic means, but it could be used as the objective of technical and well-informed farming thought. The three main aids needed are : (1) cheap and readily obtainable supplies of the right types of fertilizers ; (2) adequate and assured markets for the crops ; and (3) an enlightened and educated farming community. The latter envisages the full use of an adequate service of advisory officers and such ancillary helps as, for example, efficient soil-testing facilities. It assumes that the drainage systems and watercourses were adequate, that good seed and the necessary farming appliances and implements were available and that crop rotations and the best methods of soil cultivations, weed and disease control were understood.

The constantly increasing prices of fertilizers, due to rising costs of production, materials, freights, distribution and packaging, are a distinct deterrent to sales of fertilizers, and more stable conditions are badly needed. Statutory authority is being sought* to make a substantial contribution to the cost of fertilizers to the farmer, and it is hoped that this measure will at least arrest the tendency of the farmer to reduce the quantity he buys as the price rises. Farmers in the United Kingdom are assured of guaranteed prices for the more important crops, but there is an obvious limit to the rewards and inducements that can be offered within the economic resources of the country. The Advisory Services are of great assistance to, and much appreciated by, most of the farming community, but here again there are physical and financial limitations to what can be achieved.

* This authority has now been obtained by means of the Agriculture (Fertilisers) Act, 1952.

FERTILIZERS : SUGGESTED HIGHER LEVEL OF CONSUMPTION

A factor affecting fertilizer consumption is the policy that is being adopted in the United Kingdom to encourage the ploughing-up of land that has been down to grass for four years or more, and then to sow down the land with approved arable crops. These crops would require higher rates of fertilizer application and consequently there would be some increase in the total requirements shown in the table.

The weather plays a totally unpredictable part in the return that can be expected from the application of a given amount of fertilizer. The experience of a bad year may well discourage many farmers from maximum usage of fertilizers. This is an additional factor that has to be taken into account, particularly in the United Kingdom, with its variable climatic conditions.

Agricultural Lime

The present annual consumption of agricultural lime in the United Kingdom is between 2 and 3 million tons. Actual consumption in the last five years has been as follows :

<i>tons CaO</i>				
1946-47	1947-48	1948-49	1949-50	1950-51
1,507,400	2,258,600	2,645,500	3,138,700	2,489,300

The consumption of agricultural lime in the United Kingdom has steadily increased since 1937, when a scheme was first introduced to pay a contribution to farmers of half the delivered cost of agricultural lime. This scheme has since continued in operation with only minor variations.

To bring all agricultural land up to a satisfactory lime status, it is estimated that an immediate application of about 20 million tons CaO would be required. This estimate is based on calculations made by the Advisory Officers in the various parts of the country. It has also been calculated that an application of about 2 million tons CaO a year is required to maintain the agricultural land in the United Kingdom in its present condition. Any quantity in excess of 2 million tons helps to reduce the overall deficiency. Provided, therefore, that the present application of 2-3 million tons CaO a year is maintained, steady though slow progress will be made to the ultimate object of bringing all agricultural land in the United Kingdom to a satisfactory lime status. When that object has been achieved, it is calculated that an annual application of 3 million tons CaO will be needed to maintain the position.

It is doubtful whether it is economically possible to do more than is being done at present to achieve this object, i.e., a substantial subsidy to farmers of the delivered cost of lime and liming materials.

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